ALBERTA VEGETABLE PRODUCTION GUIDE 1987-1988

FOR COMMERCIAL GROWERS

Prepared by the
Alberta Horticultural Advisory Committee

Alberta
AGRICULTURE
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ALBERTA VEGETABLE PRODUCTION GUIDE
1987-1988

This guide is divided into six general sections:

1. General crop production management
2. Pest control management
3. Soil management and fertility
4. Irrigation
5. Vegetable production recommendations
6. Appendix

Subjects under each section are in the list of contents

This publication is for use by commercial producers and the pesticides recommended are often only available to commercial growers. Home gardeners should use chemical recommendations as given in home garden publications listed in the back of this publications.

Specific variety, pesticide and fertilizer recommendations are included under the production recommendations for each crop. (Section 5)

The amounts of material listed in the recommendations are for one acre (rates per hectare appear in brackets), unless otherwise stated. AMOUNTS OF CHEMICALS ARE GIVEN IN AMOUNT OF ACTUAL PRODUCT TO BE USED unless otherwise noted.

A number of brand or trade names are used for the convenience of readers. This constitutes neither an endorsement of the product nor a suggestion that similar products are not effective or available.

It is impossible to cover all situations in such a publications. Growers who wish more information on any areas related to vegetable production are invited to contact the appropriate personnel listed on the back cover of this guide.

WARNING

All pesticide products that are recommended in this guide are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Use of unregistered chemicals can result in seizure of the crop.

The pesticides recommended in this guide were registered at the time of writing but pesticide registrations may change. Growers are responsible for applying only registered chemicals using the correct rates and procedures. Always follow manufacturer's recommendations on the label.

The pesticides are listed in this book as a guide to producers and these recommendations have no official sanction.

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SECTION 1
CROP PRODUCTION MANAGEMENT

CLASSIFICATION OF VEGETABLE CROPS

Vegetable crops belong to the major plant families. The botanical description is complicated and not of particular importance to most vegetable growers.

A common and most practical method of vegetable classification is to group vegetables into two broad groups. These groups are cool-season and warm-season crops.

The cool-season vegetables are those of which nonflower and vegetative parts are eaten. These parts include immature flower buds (broccoli), leaves (cabbage, lettuce), stems (chard, celery) or roots (carrots, rutabagas). Of the vegetable crops that grow in Alberta, there are no exceptions to this rule.

The warm-season crops include those of which fruits, either immature or mature, are eaten. Of the crops grown in Alberta there are two exceptions to this rule. Both peas and broad beans are considered to be cool-season crops.

The basic difference between cool-season and warm-season crops lies in their temperature requirements for seed germination and plant growth. Cool-season crops will germinate and grow at lower temperatures and tend to be more cool hardy or frost tolerant.

Most of the cool-season crops grow well on the prairies. A few, such as brussels sprouts, celery, garlic and leek, require a long growing season and must be transplanted or grown from sets. Onions, also a long season crop, are grown from seed on a commercial scale in the warmest regions of Alberta and will only mature when seeded early in the spring.

Warm season vegetables

Bean (snap and dry)
Corn
Squash
Pumpkin
Muskmelon
Watermelon
Tomato
Pepper
Eggplant

Special consideration or production techniques must be applied to warm-season crops. Beans, for example, should not be planted before soil temperatures reach 15°C and although they are a short season crop, they will not set high yields of fruit in areas where night temperatures are consistently below 10°C. Sweet corn requires a long warm growing season to reach maturity. Tomatoes, peppers, and eggplant require transplanting; production is greatly improved by the use of hotcaps.

The vine crops (cucumbers, pumpkins, squash, melons) require warm days and nights to set fruit. Production is therefore often limited to southern areas and can be enhanced by the use of plastic mulch and tunnels.

Cool season vegetables

Asparagus
Broad beans
Beets
Broccoli
Brussels sprouts*
Cabbage including chinese cabbage and other cole crops
Carrots
Cauliflower
Celery**
Garlic*
Leek
Lettuce
Onion*
Parsley
Parsnip
Pea
Potato
Radish
Rutabaga
Spinach
Swiss chard
Turnip

* Requires a long season.

** Requires a long season and will go to seed (bolt) if seedlings are subjected to prolonged cool temperature.

CLIMATE OF ALBERTA

There are two aspects of climate that are especially important to vegetable production. They are the length of the frost-free season and the amount of heat received during that frost-free period. Many warm-season crops such as corn, cucumbers and beans may not mature well in central Alberta because the heat accumulated during the frost-free period is not sufficient to mature the crop even though the frost-free period is potentially long enough.

The following map shows the frost-free days (0°C base) in Alberta. The solid lines indicate the approximate number of days between the last spring frost and the first fall frost. When using the map it is important to recognize that local topography will often cause extreme differences in the frost-free period within a zone. This can occur in all parts of Alberta. Within any zone identified on the map, there are smaller areas which are actually more like one of the other adjacent zones.

The best sites for vegetable production are those where at least some of the surrounding land slopes away, even slightly. This permits the shallow layer of cold air that forms at ground level during calm nights to flow away from the area. Sometimes barriers such as hedges or dense shelterbelts will tend to trap cold air, in which case they should be avoided or thinned. Low lying pockets that tend to trap cold air should also be avoided. These factors often account for differences of several weeks in the frost-free period in areas a short distance apart.

Where large elevation differences exist, lower areas will tend to have higher daytime temperatures, e.g., approximately 2°C per 300 m (1000 ft). That is why in the Peace River valley, for example, there is more heat available for crop growth than at a higher elevation outside the valley.

Although two regions may have similar frost-free periods, there may be differences in the amount of heat received in the two areas. For example, Brooks and Edmonton have similar frost-free periods, however, Brooks receives more heat. The night-time lows and day-time highs are generally higher in Brooks. For this reason, warm season crops like cucumbers or sweet corn will normally mature earlier in the southern area than the northern area.

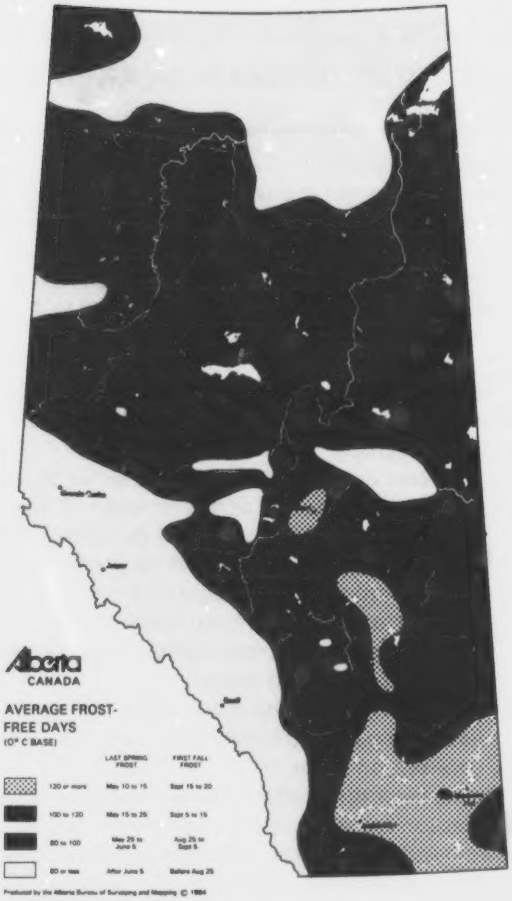


Table 1 gives frost data for some locations in Alberta.

SEEDING AND PLANTING VEGETABLE CROPS

There are many factors to consider when seeding or planting. Aside from considering what to grow and how much to grow, growers should be aware of some physical requirements of the seeding operation and how to use several production techniques to make their land as productive as possible.

The following is a brief discussion of the requirements and alternatives to consider when seeding or planting.

Seedbed preparation

Seeds should be sown into a seedbed that will give the seed good contact with the soil. Normally, a finely prepared yet firm seedbed is requiredSeedbeds should be free from lumps and clods, a problem common in seedbed preparation when working the soil too early in the spring, particularly in fine textured soils.

Soil moisture and temperature

Seeds require both adequate soil moisture and warmth to germinate. Seeds should be planted into moist soil so as to avoid the need for irrigation immediately after seeding (soil crusting problems inhibit seedling emergence). Excessively damp soils should be allowed to dry prior to seeding, otherwise seeds will decay because of a lack of oxygen.

The soil temperature around the seed must be at a minimum level for germination to begin. Early

Table 1
FROST DATA FOR SOME LOCATIONS IN ALBERTA
Data are taken from Environment Canada, Frost Data 1941-1970

Location	Altitude	No. of years recorded	Av. frost-free period	Av. date of last spring frost	Av. date of first fall frost
Athabasca	1700	23	70	June 15	Aug. 25
Bow Island	2612	10	125	May 18	Sept. 20
Brooks	2487	28	114	May 23	Sept. 16
Calgary (airport)	3540	30	106	May 28	Sept. 12
Cold Lake	1784	18	112	May 26	Sept. 16
Coronation	2618	30	111	May 25	Sept. 13
Drumheller	2255	25	108	May 25	Sept. 12
Edson	3033	30	67	June 18	Aug. 25
Fairview	2160	30	111	May 21	Sept. 10
Edmonton (Fort Saskatchewan)	2050	13	115	May 19	Sept. 14
Fort Vermilion	915	30	91	June 6	Sept. 6
Grande Prairie	2190	29	113	May 19	Sept. 10
High Prairie	1965	30	91	June 2	Sept. 1
Lac la Biche	1835	12	97	June 1	Sept. 7
Lethbridge (airport)	3018	30	118	May 21	Sept. 16
Medicine Hat	2365	30	125	May 17	Sept. 20
Peace River (airport)	1866	17	88	June 3	Aug. 31
Red Deer	2820	22	105	May 28	Sept. 11
Rimbey	3020	10	107	June 1	Sept. 16
Rocky Mountain House	3330	26	95	May 31	Sept. 5
Stettler	2700	30	114	May 22	Sept. 14
Strathmore	3160	21	109	May 23	Sept. 10
Taber	2650	24	127	May 15	Sept. 21
Vegreville	2082	29	99	May 30	Sept. 7
Vermilion	2037	26	90	June 5	Sept. 4

seeding is beneficial in some crops but planting into excessively cold soils often results in seed decay. Most vegetable seeds will germinate at temperatures from 5° to 15°C.

Seeding management techniques

Vegetable growers should consider alternatives within their production program which will provide for better use of labor and land, thereby expanding markets and reducing waste.

Several techniques can be used to expand the marketing period. These include: the use of transplants as well as direct seeding; the use of plant protectors, such as hotcaps and row covers; seeding several varieties that differ in maturity; seeding portions of a crop over several weeks (successive seeding) and storage. Storage requirements and management are covered later in this section.

By using some of these planting techniques, growers extend the marketing season and tend to reduce waste because vegetables are harvested over a longer period which reduces the chance of a short-term oversupply of produce.

Seeding and spacing requirements

Growers need to know the optimum spacing requirements of a crop and how best to achieve those spacings. Because of many factors, such as weather, disease, insects, and seed viability, the final number of plants growing is always less than the number of seeds planted.

Table 2 lists the approximate seed and spacing requirements for some vegetable crops. To achieve these spacings, the following sections discuss methods of planting and some factors to consider to achieve the desired spacing.

Table 3 shows the number of plants per acre (hectare) at various between-row and in-row spacings.

Establishing a desired plant stand

There are three basic mechanical methods which can be used in planting a vegetable crop. They are: 1) drill-type seeding (and thinning if necessary) 2) precision seeding and 3) transplanting.

Drill-type seeding

An inferior method of planting vegetable crops is to use a drill-type seeder that generally places large amounts of seed in the row at irregular intervals. The disadvantage of this method is that large amounts of seed are often wasted and that for many crops thinning is required after emergence to obtain the desired spacings. This method is generally undesirable for root crops and for crops that produce single harvestable units above ground, such as cabbage and cauliflower.

This method can ensure that the desired population is achieved, but this seeding method may result in lack of spacing uniformity. Thinning a crop seeded with a drill-type seeder is time consuming and can be costly.

Precision seeding

The introduction of precision seeders has drastically changed the way vegetable crops have and should be grown. Most crops can be grown closer than at current conventional spacings. Closer spacing allows for more crop on the same unit of land. Each crop should be spaced according to its need, e.g., seeding carrots 2.5-3.0 cm (1-1.5 in.) apart in all directions will produce a high yield of well-formed roots; lettuce seeded in beds and spaced 30 cm (1 foot) between plants will produce more heads per unit of land, as well as a much higher percentage of marketable heads; onions sown in double rows 5.0-7.0 cm (2-3 in.) apart with 4 to 6 of these double rows per bed not only will produce large onions, but much higher yields. The same can be said for many other crops. As plants reach the optimum spacing for their particular needs, growth improves and yields increase.

To obtain the optimum plant density, a system of precision seeding is needed. This system starts with the preparation of a fine smooth seedbed, followed by seeding at a uniform depth, at exact in-row and between-row spacings.

Precision seeders have been developed that can place seeds at specified uniform distances in the row. Whereas these seeders are often more expensive to buy than conventional drill-type vegetable seeders, they have cost saving advantages. Normally less seed is used, labor required for thinning is reduced or eliminated, and more uniform crops can be grown. For example, with precision seeding, crops like carrots, onions and rutabagas will be more uniform in size and shape. Generally, less effort will be required in grading and packing and fewer culls are obtained. However, to achieve complete success with precision seeding, all factors--seed sizing, seed coating, high germination, good seedbed preparation and uniform seeding depth--must be included. By omitting just one factor, the results may be no better than with more conventional seeding methods.

A common type of precision seeder is the Stanhay belt seeder. It is a versatile seeder that can be used to seed most vegetable crops using either a rubber or plastic belt. It offers the advantage of being able to seed crops like carrots in wide 7.5-10.0 cm (3-4 in.) bands as opposed to narrow single rows. Often more crop can be grown and harvested per unit of row when seeds are planted in a wide band.

Crops that are well suited to precision seeding with the Stanhay seeder and the type of belt required for row seed:

Asparagus (rubber, single rib)
Sweet corn (rubber, single rib)
Beets (rubber, triple rib)
Cucumbers (rubber, smooth)
Broccoli (rubber, smooth)
Lettuce (plastic)
Cabbage (rubber, smooth)
Onion (rubber, smooth)
Cauliflower (rubber, smooth)
Parsnip (rubber, smooth)
Carrots (plastic)
Rutabaga (rubber, smooth)

Table 2a

SEED AND SPACING REQUIREMENTS FOR VEGETABLE CROPS (METRIC)

		.......Seed required........			Desired final plant		
			......Per hectare......		.........spacing.........		
Vegetable	Approx.* seeds per (g)	For 50 m row seeded direct (g)	Transplant (g)	Seeded direct (kg)	Apart in rows (cm)	Between rows (cm)	Depth of planting (cm)
Asparagus	25-50	50	2240	6-7	30	90-120	2.5-4.0
Bush bean	3-4	740	-	50-90	2.5-5.0	60-90	4.0-5.0
Beet	60	45	-	11-18	2.5-5.0	30-60	1.0-2.5
Broccoli	300	12	280	0.5-3	30-45	45-75	1.0-2.0
Brussels sprouts	280-320	12	280	-	45-60	45-90	-
Cabbage	280-320	12	280	0.5-3	40-50	60-90	1.0
Carrot	425-900	25	-	3.5-6	2.5	45-60	1.0
Cauliflower	280-320	12	280	0.5-3	30-45	60-90	1.0
Celery	1760-2470	12	280-560	-	15-20	45-60	-
Corn, sweet	4-7	200	-	11-17	15-35	55-90	2.5-5.0
Cucumber	36	25	1120-2240	3.5-6	7-15120-360	2.5-5.0	
Eggplant	200	6	280		45-60	60-90	-
Lettuce	700-900	25	560	1-3	20-35	30-60	1
Onion	280-350	50	-	3.5-4.5	5-10	30-60	1.0-2.5
Parsnip	210-425	25	-	3.5	2.5-7	45-60	0.5-1.5
Peas	4-9	740	-	55-340	2.5-7	15-60	2.5-5.0
Pepper	140-160	6	280	-	30-45	45-75	-
Pumpkin	4	25	1120-2240	3.5-4.5	90-120	480-720	2.5-5.0
Radish	70-125	50	-	11-17	2.5	20-30	0.5-1.5
Rutabaga	280-425	25	-	0.5-3	10-15	60	1.0-2.5
Spinach	100	50	-	17	5-10	30-45	1.0-2.5
Squash	4-11	25	1120-2240	1-3.5	90-120	90-480	2.5-5.0
Tomato	350-400	6	140	-	45-60	60-90	-

* May vary considerably.

Table 2b

SEED AND SPACING REQUIREMENTS FOR VEGETABLE CROPS (IMPERIAL)

		.......Seed required........			Desired final plant		
			......Per hectare......		.........spacing.........		
Vegetable	Approx.* seeds per ounce	For 50 m row seeded direct (oz)	Transplant planted	Seeded direct (lb)	Apart in rows (in.)	Between rows (in.)	Depth of planting (in.)
Asparagus	700-1500	1	2 lb	6	12	36-48	1-1½" in furrows
Bean bush	60-100	1 lb	-	45-80	1-2	24-36	1½-2
Beet	1600	1	-	10-16	1-2	12-24	½-1
Broccoli	9000	½	4 oz	½-2	12-18	18-30	½-3/4
Brussels sprouts	8-9000	½	4 oz	-	18-24	18-36	-
Cabbage	8-9000	½	4 oz	½-2	16-20	24-36	½
Carrot	12-25000	½	-	3-5	1	18-24	½
Cauliflower	8-9000	½	4 oz	½-2	12-18	24-36	½
Celery	50-70000	½	4-8 oz	-	6-8	18-36	-
Corn, sweet	100-200	½ lb	-	10-15	6-14	22-36	1-2
Cucumber	1000	½	1-2 lb	3-5	3-6	4-6 ft	1-2
Eggplant	6000	1/8	4 oz	-	18-24	24-36	-
Lettuce	20-25000	½	8 oz	1-2	8-14	12-24	½
Onion	8-9500	1	-	3-4	2-4	12-24	½-1
Parsnip	6-12000	½	-	3	1-3	18-24	¼-½
Peas	100-250	1 lb	-	50-300	1-3	6-24	1-2
Pepper	4-4500	1/8	4 oz	-	12-18	18-30	-
Pumpkin	100	½	1-2 lb	3-4	3-4 ft	8-12 ft	1-2
Radish	2-3500	1	-	10-15	1	8-12	¼-½
Rutabaga	8-12000	½	-	½-2	4-6	24	½-1
Spinach	2800	1	-	15	2-4	12-18	½-1
Squash	100-300	½	1-2 lb	1-3	3-4 ft	3-8 ft	1-2
Tomato	10-11000	1/8	2 oz	-	18-24	24-36	-

*May vary considerably.

Table 3a
ROW-METRES PER HECTARE AND NUMBER OF PLANTS PER HECTARE AT VARIOUS PLANT SPACING

Distance between rows (cm)	**Row-metres per ha**	**Distance between plants within the row (cm)**								
		2.5	**5.0**	**10**	**15**	**30**	**45**	**60**	**75**	**90**
		Number of plants per hectare								
30.5	32,800	1,311,440	655,720	324,610	215,700	107,850	71,740	53,840	43,030	35,870
45.7	21,900	875,240	437,620	216,640	143,950	71,980	47,880	35,930	28,710	23,940
60.9	16,400	656,800	328,400	162,570	108,030	54,010	35,930	26,960	21,550	17,960
76.2	13,100	524,920	262,460	129,930	86,330	43,170	28,710	21,550	17,220	14,360
91.4	10,900	437,600	218,800	108,320	71,980	35,990	23,940	17,960	12,360	11,970
106.6	9,400	375,200	187,600	92,870	61,480	30,860	20,525	15,400	12,310	10,260
121.9	8,200	328,120	164,060	81,220	53,970	26,980	17,950	13,470	10,770	8,970

Example: At a 60 cm between-row spacing there are about 16,400 m or rows per hectare. There are 35,930 plants per hectare when planted at 45 cm between plants in rows 60.9 cm apart.

Table 3b
ROW-FEET PER ACRE AND NUMBER OF PLANTS PER ACRE AT VARIOUS PLANT SPACINGS

Distance between rows (inches)	**Row-feet per ac**	**Distance between plants within the row (inches)**								
		1	**2**	**4**	**6**	**12**	**18**	**24**	**30**	**36**
		Number of plants per acre								
12	43,500	525,000	260,000	130,680	87,120	43,560	29,040	21,780	17,420	14,520
18	29,000	350,000	175,000	87,120	58,080	29,040	19,360	14,520	11,620	9,680
24	22,000	260,000	130,000	65,340	43,560	21,780	14,520	10,890	8,710	7,260
30	17,500	210,000	105,000	52,270	34,850	17,420	11,620	8,710	6,970	5,810
36	14,500	174,000	87,000	43,560	29,140	14,520	9,680	7,260	5,810	4,840
42	12,500	150,000	75,000	37,340	24,890	12,450	8,300	6,220	4,980	4,150
48	11,000	130,000	65,000	32,670	21,780	10,890	7,260	5,450	4,360	3,630

Example: At a 24 inch between-row spacing there are about 22,000 feet of row per acre. There are 14,520plants per acre when planted 18 inches between plants in rows 24 inches apart.

Emergence is never perfect; therefore some crops should be precision seeded at double or triple the final stand. Cabbage and cauliflower are good examples. If a 30 cm (12 in.) in-row spacing is desired it may be necessary to plant every 15 cm (6 in.) to ensure a near perfect stand. In this case some thinning may be required, however, the time required to thin is greatly reduced compared with a crop sown by a drill-type seeder.

Several types of precision seeders are available. Details on this equipment can be obtained from the Alberta Tree Nursery and Horticulture Centre in Edmonton or from the Alberta Horticultural Research Center in Brooks.

Graded or Sized Seed

When using nonpelleted or raw seed, it is essential that the seed be graded by size. Some suppliers can provide graded seed, however, grading must be accurate. When using belt type seeders, the largest seed must pass easily through the holes in the belt, but not more than two of the smallest seeds should pass side-by-side through the same hole. Small quantities of seed can be graded at home or in the shop by using a series of sieves. Seed of cole crops (broccoli, brussels sprouts, cauliflower, cabbage), radish, beans, onions, rutabagas and turnips have been successfully sized. Onions and carrots present more of a problem because of their irregular seed shape.

Pelleted seed

Pelleted or coated seed is available from many seed companies at considerably more expense than raw seed. Seed coatings vary in formulations and in the volume applied to seeds. Most pelleted seed in an individual lot is fairly uniform in size and can be used as recommended. However, occasionally a few larger pellets are formed and these can be a nuisance when seeding. A minimum rather than a maximum coating is recommended. Pelleted seed must have a high germinating capability. Seeds with a low germination count defeat the purpose of precision seeding and should not be pelleted. Pelleted seed used in Alberta has generally resulted in poor germination, particularly under a sideroll irrigation system. Frequent, light water application available through a center pivot irrigation system generally results in better germination of pelleted seed.

Seed germination

Seed viability varies according to plant species, according to age and according to seed lot. Normally, pelleted seed has a germination rate of 80% or over. Most cole crops have over 90% germination but seeds of crops such as parsnips can be as low as 70%. In other words, only 7 out of every 10 seeds will produce a plant even under ideal conditions. This is accounted for in the field factor.

Field factor

Planting conditions are seldom ideal. The soil may be too wet or too dry, too cold or too warm, too loose or too packed. If soil conditions are good, most seeds will germinate, but fewer seedlings will emerge if conditions are poor.

The field factor is used to estimate soil conditions and the effect these conditions will have on seedling emergence. Under ideal conditions a field factor of 0.8 can be applied. Under normal conditions a factor of 0.6 - 0.7 is common. Under still poorer conditions, the factor can be 0.4 or 0.5 or even lower. Irrigation improves germination by increasing the field factor. Centre pivot systems offer the best germination and early seedling field conditions.

The field factor must be applied to viable seeds only. If a germination count of 80% was given and a field factor of 0.7 applies, only 56% of the seeds sown will emerge from the ground.

$$0.8 \times 0.7 = 0.56 \text{ or } 56\%$$

If the germination count is only 70% with the field factor of 0.6, only 42% of the seed will produce plants.

If a precise stand is required under these conditions, seeding should be done with a belt that will drop two seeds per hole rather than just one. An alternative is to use a belt with twice as many holes. However, this may result in the need for thinning.

Transplanting

The advantages of transplanting are numerous. In Alberta several vegetable crops will not mature if grown directly from seed in the field. Transplants provide the necessary advanced growth to ensure a harvested crop before frost. Tomatoes, peppers, brussels sprouts, celery, eggplant, melons and other long and warm season crops are examples. Other crops, which will normally mature when direct seeded, can be transplanted so that they can be marketed early when prices are normally higher. This in effect extends the growing season of thatcrop. Examples include cabbage, cauliflower, broccoli, lettuce, cucumbers and squash.

Transplanting ensures a near perfect plant stand which maximizes other management inputs. Crops grown from transplants are normally more uniform in size, shape and maturity. These factors can reduce harvest and grading costs.

Transplants can also provide some degree of insect control. Emerging cabbage and other cole crop plants can be totally destroyed by flea beetle infestations in the field. A method of eliminating the need for chemical insect control is to use transplants. Although they will be attacked, strong transplants will normally survive flea beetle infestations.

Transplants are not cheap and experience in transplant production is necessary if a growers plan to grow their own. Importing transplants is a cheaper alternative practiced by many growers.

For more information about transplant production and transplant equipment contact the Alberta Tree Nursery and Horticulture Centre in Edmonton, or the Alberta Horticultural Research Center in Brooks.

PRODUCTION OF WARM-SEASON CROPS

A warm season crop is one which requires a long warm growing season in which to mature its fruit. Cucumbers are an exception since the fruit is harvested in an immature stage. Warm-season crops are not as frost hardy as cool season crops, they need warmer soil temperatures to germinate and chilling injury can occur between 0°C and 10°C.

Crops such as watermelons and peppers require a warmer climate than tomatoes and cucumbers. To satisfactorily grow and harvest warm-season crops, a number of techniques can be used to modify and enhance the growing conditions. These include using transplants, hotcaps, mulches, row covers and combinations of these.

Transplants

Transplants grown indoors and then transplanted into the field will advance production by 2-4 weeks. Transplants can be used for almost all warm-season crops and are generally used for tomato, pepper, eggplant and melon. Transplants can also be used to grow earlier maturing cool-season crops.

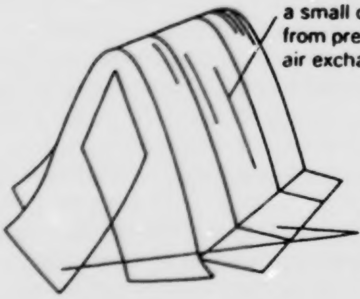
Hotcaps

A hotcap is a waxpaper tent held to form by thin wires. Hotcaps are available from most horticultural suppliers. Large size hotcaps are recommended as they allow for more space in which the plant can grow.

When using hotcaps, transplants can be put into the field tow to three weeks earlier than normal as the hotcap provides two to four degrees of frost protection. Plants can be set out as early as May 15 with hotcaps for frost protection.

After the hotcap is placed over the watered-in transplant and soil is placed on the flaps to hold it down, a 5 cm (2 in.) cut is made on the leeward side (side opposite prevailing winds) of the hotcap. About once every week the size of the cut can be doubled for 4-5 weeks after field setting, at which time the hotcap can be removed. By this time the plants should be well established and there should be no danger of frost. The hotcap is not reusable.

Hotcaps should be used with crops such as tomatoes, peppers, eggplants, melons, and may also be used on cucumbers, or any warm-season crop to advance maturity.


a small cut on the side away from prevailing winds allows fo air exchange
place soil on all flaps around the base of th hotcap to secure it to the ground

Plastic Mulches

Various types of plastic mulches have been tested throughout the province, but to date both the clear and black mulch appear to be the most beneficial. When using clear mulch, a herbicide must be used to control germinating weeds under the plastic.

Plastic mulches conserve soil moisture, transmit heat that they absorb directly into the soil (soil temperature increases), and in the case of black plastic, control weeds. A number of crops have been tested on mulches; vine crops have been found to benefit most from their use.

The plastic mulch can be laid by hand or laid down with a commercial mulch applicator. There are several of these plastic mulch applicators in the province. A 2 mil by 120 cm (48 in.) plastic is most commonly used. The soil must be well prepared and smooth to ensure a tight union between the plastic andsoil, especially important to allow for the efficient transfer of heat to the soil. Rototilling the soil prior to the application of the plastic mulch permits a smooth, lump-free soil surface. The edges of the plastic should be well buried with soil to prevent wind from picking up the mulch. Approximately 15 cm (6 in.) of plastic on both sides of the mulch is buried so from a 120 cm (48 in.) wide plastic roll only 90 cm (36 in.) of mulch is exposed. Cross cuts in the plastic at 30 cm (12 in.) apart can be made down the centre of the mulch and seeds or transplants set into the holes. Spacing will depend on the crop planted, care should be taken so as not to make holes too close together as wind may tear the plastic hole to hole and the mulch would therefore be useless. A plug-mix planter successfully plants seeds through the plastic mulch so the hand labor aspect of planting the crop is mechanized.

Normal irrigation practices will ensure adequate water supply.

Perforated plastic row covers

Row covers are of tremendous benefit when used in combination with black or clear plastic mulch. Row covers must be used in combination with plastic mulch otherwise severe moisture stress occurs and plants die. Vine crops appear to benefit most from the use of the row cover. Row covers are not recommended for use on tomatoes as fruit set is greatly delayed.

A 2 mil by 1.8 m (6 ft) wide roll of clear plastic is bored with 2.0 cm (3/4 in.) holes approximately every 30 cm (8 in.) in all directions. The holes are needed for ventilation. Current suppliers of row cover plastics in Alberta manufacture perforated plastic for use as row covers.

Wire hoops made of 180 cm (6 ft) pieces of no. 9 galvanized wire are placed over the row approximately 81 cm (32 in.) apart and each end of the wire should be inserted 15 cm (6 in.) into the soil. Wire inserting machines are available and eliminate this hand labor aspect. Galvanized wire is recommended to prevent rusting of the wire which speeds up deterioration of the plastic. The plastic is then stretched over the hoops, either by hand or by machine, fastened at both ends to a stake driven into the ground or held in place with soil and all edges buried with soil.

Seeds should be planted into moist soil and transplants should be watered in prior to application of the row cover plastic. A plug-mix planter does a good job of planting seeds through plastic mulches, however, transplants must still be set by hand through plastic mulch. Roots will spread out quickly and normal sprinkler irrigation will ensure an adequate supply of moisture.

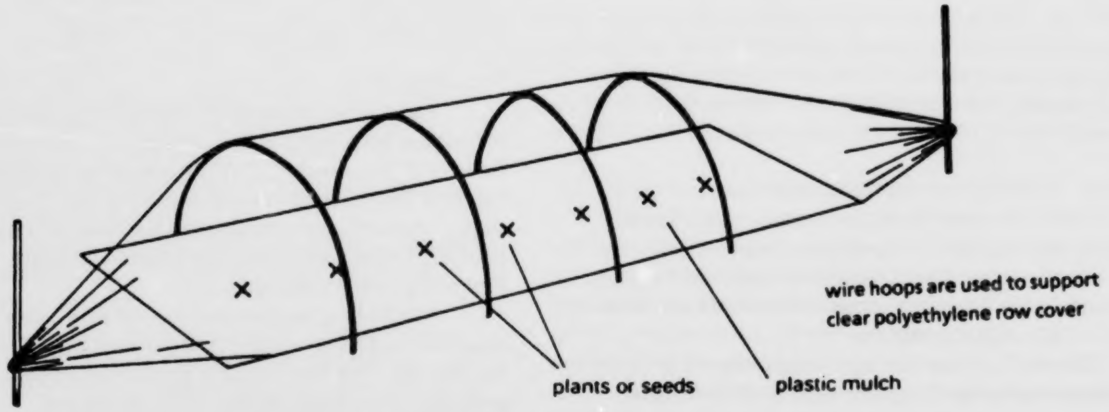
It is important to note that row covers give very little frost protection.

The row cover plastic should be removed when vine growth reaches to the edge of the plastic cover, when flowering commences, or if plants appear to be suffering from scorch.

The plants inside a row cover will be growing in a modified greenhouse atmosphere, thus removal of the tunnel should be done a cool, cloudy day to reduce plant shock. Slitting the row cover down the middle at least two days before removal helps to gradually introduce the covered plants to the outdoorenvironment. Then the row cover plastic can be completely removed.

HARVEST MANAGEMENT

Vegetable and potato quality are directly related to harvest timing and post-harvest handling. Harvest timing is generally dependent on product maturity, which can be recognized by color change, skin set, size and numerous other factors. Harvesting at the right stage of maturity is often difficult, but critical to good quality.



Perforated plastic row cover

Whether harvesting is done by machine or by hand, care must be taken to avoid mechanical damage. Bruising can cause discoloration or decay and may reduce the grade of the product.

Vegetable quality in terms of flavor, color and size generally improves as a product reaches maturity. However, the perishable nature of vegetable products means that quality will begin to decline after a maturity peak is reached. Growers should be able to judge optimum maturity for all products produced.

Deterioration in quality continues after harvest, and how products are handled will determine the rate and eventual extent of the deterioration.

STORAGE AND STORAGE MANAGEMENT

Many vegetables can be satisfactorily stored for a relatively long term in the proper storage environment. Providing suitable storage conditions is the key to successful storage.

Storage design and planning may be considered in the following important categories:

- Storage requirements of vegetable types and varieties is of first importance.
- Environmental control - temperature, humidity, ventilation and related control systems and management.
- Functional design - to provide the correct amount of storage, plus equipment and facilities for handling, grading and marketing of produce.
- Structural - ensure that the storage building is designed for wind and snow loads, and the force of piled vegetables, earth pressure or equipment loads. Storage must be very well insulated with a good vapor barrier properly sealed and located.

This section summarizes storage requirements for typical market garden or smaller commercial production. The same principles apply to home storage of vegetables, though there is a large variety of these storage systems. Large, commercial storages require specialized design of the structure, cooling loads and related mechanical equipment.

Storage conditions for vegetables

Proper storage conditions are critical. These differ for various types or groups of vegetables. Table 4 summarizes these requirements. The notes following Table 4 explain some of the more detailed aspects of storage management.

Obviously, since storage requirements differ, only those crops requiring similar conditions store well together; thus the groupings of Table 4. Some groups of vegetables tolerate a compromise of conditions where shorter storage life or lower quality of one commodity may result. For example, both potatoes and root vegetables require high humidity; however, potatoes should not be stored cooler than 5°C, while root vegetables store best at 0°C. It is best to construct separate rooms for each. However, where these crops have to be stored together, store everything at 4-5°C, and high humidity. This results in somewhat shorter storage life (though good for 3 months) for root crops, without causing undue damage (sweetening) to the potatoes.

Though each crop has its storage requirement, the following recommendations are important for all crops:

- harvest only mature crops
- grow varieties that store best.
- remove all diseased or damaged produce before storing
- handle carefully to avoid damage
- precool cold storage crops or try to harvest in cool conditions, such as early morning.
- wet floors of storage ahead of time (particularly earth floors).
- if frost-damaged, diseased or immature crops must be stored, try to store separately and market early.

Planning and functional design

The size, type and layout of storage should be determined. Several items to consider in making this decision are:

- the size and number of individual bins required
- varieties or types of produce; which ones may be stored together
- storage layout for convenient handling
- receiving and rough grading at harvest prior to storing
- future expansion or modification
- utilities and services required
- possible washing, grading or packaging facilities
- water supply and waste water disposal.

Storage size

Total storage volume, size and number of individual bins, should be considered. Storages vary from one large room, to multiple-bin structures. Storage facilities with several bins or rooms are more costly. Advantages are smaller batches for better control, lower risk of storage losses and more flexibility in bin management.

Marketing requirements, varieties, cropping conditions, and storage management affect storage bin design. The seed potato grower or vegetable producer may need several bins, while the

Table 4.

Storage conditions for selected fruits and vegetables.

Storage Type	Produce	Bulk[6] Density (kg/m^3)	Pile Depth m	ft	Temp. °C	Relative Humidity (%)	Storage Period (months)
Fruits[1]	Apples	600		0-1	90-95		varies; highly variety dependent, up to 12 months
Cold and .Humid	Beets	650	3-4	10-14	0-1	90-95	4-6
	Cabbage[4]	500	2-3	6-10			2-6
	Carrots	550	3-4	10-14			4-6
	Parsnip	500	2½-3½	8-12			2-5
	Radish	600	-	-			0.5-3
	Rutabaga	650	3-3½	10-12			4-6
Cool and .Humid	Potatoes	670	4-6	14-20		90-95	5-10
	- seed				4-5		
	- table				5-6		
	- process[2]				7-9		
Cool and Less Humid	Squash[5]	500	3-3½	10-12	10-12	70-75	4-6
	Pumpkin						2-4
Cold and .Dry	Onions[3] (cured)	600-700	2-3	6-10	0-3	70-75	4-8

Notes:

1. Commmercial storage of apples involves controlled atmosphere (CA) technology. Do not store vegetables and apples together because apples give off ethylene which causes off-flavors in carrots, parsnips and other vegetables.
2. Potatoes are normally cured 2-3 weeks at 10-15°C and high RH, then cooled slowly to storage temperature. Storage conditions highly dependent on variety and use.
3. Onions are either field cured, or cured in storage at 32-36°C with high air flow prior to long term storage.
4. Cabbage storage quality and time is highly variety dependent.
5. Squash and pumpkin should be well ripened; cure at 30°C then reduce temperature.
6. Bulk density varies 5-10%, use as a guide for estimating storage size requirements. (kg/m^3 x 0.0625 = lb/ft^3 or kg/m^3 ' 16 = lb/ft^3).
7. Most produce, particularly cabbage and potato, react to light; store in dark conditions.

commercial potato producer will find one or two bin bulk storages are best.

Bulk storage size can be estimated from bulk density data, Table 4. Plan storage capacity for above-average yield, and future expansion or changes, such as an added grading room or loading shed, or refrigeration system. Consider that it is not usually feasible to fill storages full depth right to the doors, unless heavy doors or bulkhead systems are constructed.

Pallet bin type storage capacity is determined by laying out the required number of bins in tiers and rows. Stacking height is often determined by limits of stacking equipment, usually 4 to 6 tiers high. Most pallet bins fit a 1200 x 1200 mm (48 inch) module. Therefore the most efficient room size has inside dimensions equal to a certain number of rows plus 300 mm (12 inches).

Storage types and construction

Storages are of two general types, (1) bulk storage and (2) palletized storage. Various building systems can be adapted to either storage type. Storages can further be classified according to the produce type, or whether "refrigerated" or "air-cooled".

In general, any type of building can be a good storage, provided it is structurally adequate, well

Storage	Building costs	Ventilation system
Bulk potato storage 1,000-2,000 tonnes	$75-$90/tonne	$10,000-$14,000
Bulk vegetable storage 500-1,000 tonnes	$125-$195/tonne	$8,000-$12,000
Palletized vegetable storage	$175-$225/tonne	
Pallet bins	$130-$160/tonne	
Refrigeration system for pallet or bulk type storage	$100-$150/tonne	(included)

insulated, and meets the functional needs. Environmental control, together with a good insulation system, is the key element to good storage.

The *following diagram* illustrates some of the most common storage designs used in Alberta.

For *bulk* storage, the produce is piled in room-size bins, thus the pressure exerted by the pile must be contained by the bin walls. These forces are large and should not be underestimated in the building design. Ventilation of bulk storage is accomplished by blowing conditioned air through the pile of produce from a duct system placed under the pile.

Bulk storage is generally less costly. It is best for crops that can be handled in bulk and piled fairly deep such as rutabagas, beets, potatoes and onions, and to a lesser extent, carrots and parsnips.

Palletized storage has the crop placed in large boxes (pallet bins) which in turn are stacked in the storage room. The crop does not exert pressure on the walls, thus the building need be designed only for climatic loads.

Pallet bin storage is generally used for crops that bruise easily or cannot be piled, such as fruit, cabbage, parsnip, carrots and greenhouse crops. Palletized storage allows mixing of varieties or types of crops, as well as crops from several growers. Bins can be selectively marketed, and problem bins can be removed with less danger or wide spread spoilage. It is the preferred storage for warehouses and plants where produce turnover is frequent.

Air of proper temperature and humidity is circulated between rows of pallet bins. Small quantities in pallets may be handled and stacked by forklifts and pallet dumping equipment.

Most storages deal with high humidity and controlled temperature. Though storages may be of wood frame, steel or concrete, high levels of insulation and moisture resistance are required. Vapor barriers must be thorough and effective. For coldest Canadian climates, minimum insulation factors should be: for walls RSI 5.5 (R31) and for ceilings RSI 6.5 (R37).

Some principles to consider, whatever the construction type, are:

- insulate foundations, preferably on the exterior.
- pay particular attention to thermal bridge or cold spots in normally good wall or roof systems that can cause serious condensation problems. Solid studs, steel purlins and beams, and discontinuous insulation at foundations or plates are typical problem areas.
- durability and ease of sanitizing are important.

Structural design notes

Pallet type storage buildings, like other buildings, should be designed for wind and snow loads; however, consider the possibility of designing for a change to bulk storage in the future. Highest floor loads are caused by forklift wheels.

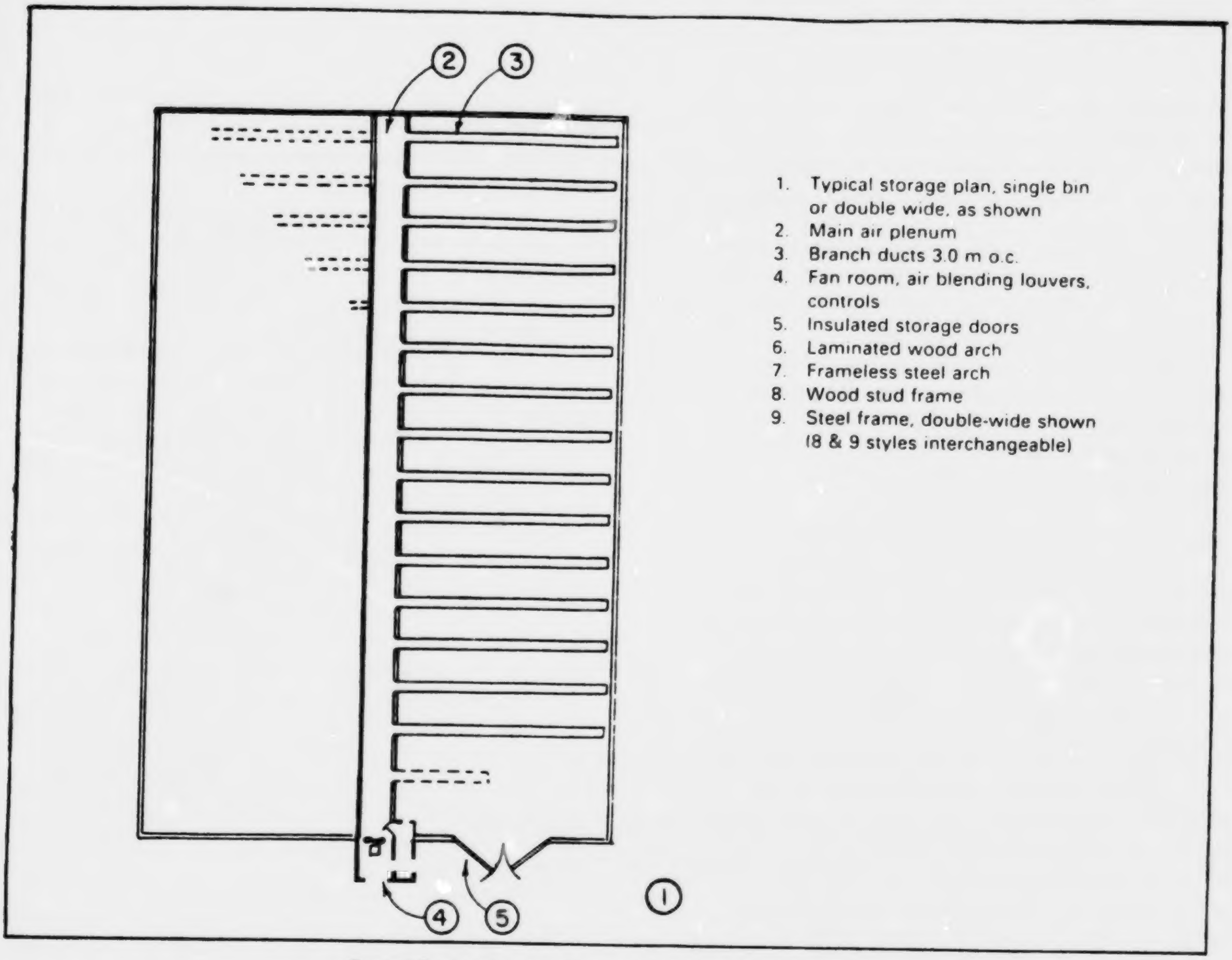
Bulk storage, in addition to climatic loads, must also withstand the wall pressure of piled produce. Bin walls require some structural engineering and these details are provided by Alberta Agriculture standard plans available from district agriculturist offices. Forces and bending stress can be great, and structural requirements should not be underestimated.

Pay particular attention to wall member strength, top and bottom wall connections, foundation side force, and force on rafters due to wall pressure. For example, a 4.8 m (16 foot) high potato pile exerts bottom and top plate forces of about 16.0 and 7.3 KN/m^2 (1200 and 500 lb/sq ft) respectively.

Treated wood is not permitted in the interior of a vegetable storage; either where vegetables may contact treated wood, or where moisture may drip from treated wood onto the produce. In wood frame construction, pressure treated sills and butt-treated studs are a desirable precaution against decay in these critical structural areas. Use water based CCA or ACA preservative. Do not use volatile and smelly pentachlorophenol or creosote.

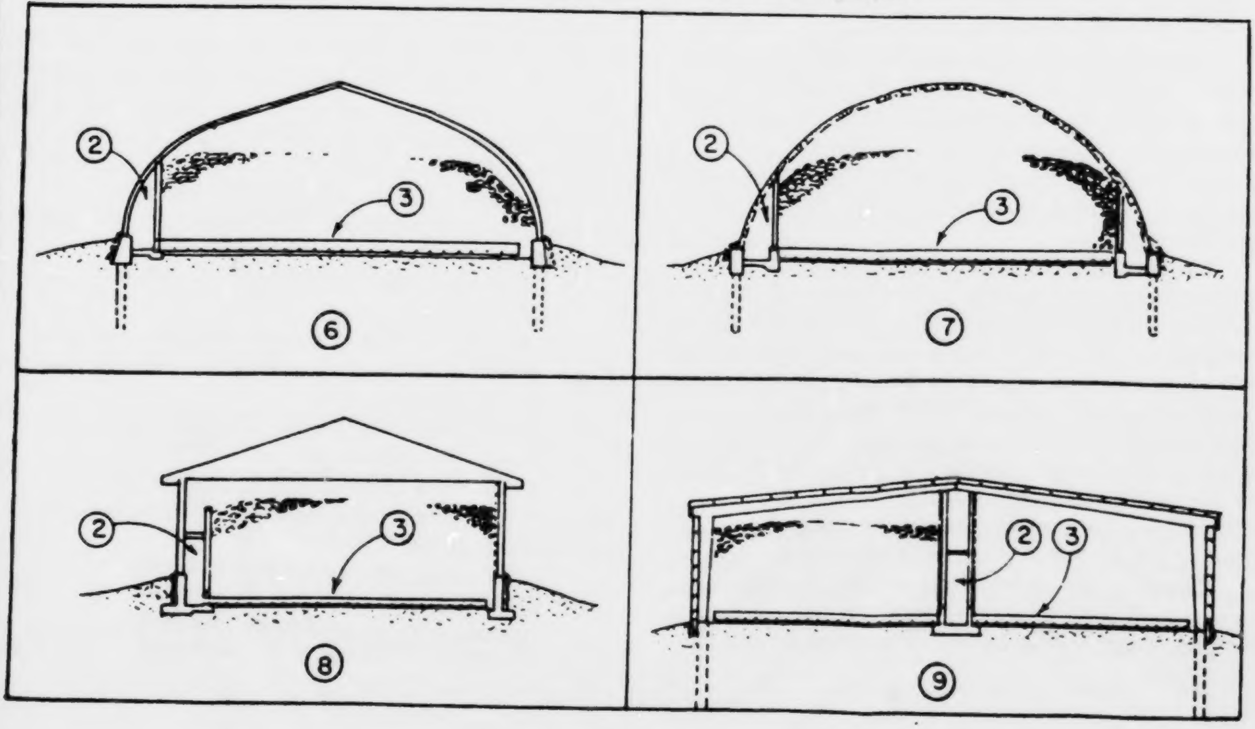
Construction costs

The cost of new storages is highly variable depending on many structural and environmental factors. Too few vegetable storages have been built to determine average values; but good cost data are



1. Typical storage plan, single bin or double wide, as shown
2. Main air plenum
3. Branch ducts 3.0 m o.c.
4. Fan room, air blending louvers, controls
5. Insulated storage doors
6. Laminated wood arch
7. Frameless steel arch
8. Wood stud frame
9. Steel frame, double-wide shown (8 & 9 styles interchangeable)

Typical Potato Storage Plan and Alternate Building Types



available for potato storages. In addition to the cost of storage space and related environment controls, a sizable portion of the project is sometimes required for the working area and grading and handling equipment.

The following are some typical costs for storages based on 1984 construction costs. These storages are well insulated, with concrete floors, and represent a range in building types.

A lower quality storage facility such as a root cellar can be built for up to half the above costs. Vegetable storage life, overall building life plus maintenance, and care of handling and operating will probably be compromised.

Environmental control

This implies the control of temperature, humidity and air flow to provide proper storage conditions. This is accomplished by circulating the correct amount of conditioned air through the pile or past the pallet bins in a storage.

Storages may be either air-cooled or refrigerated, or both. For air-cooled storage, temperature is controlled by blending the correct amount of cold outdoor air into the ventilation system. This requires outdoor temperatures below the storage temperature for all but short periods during most of the storage season. In general, this applies to potato, onion and squash storages. Nonrefrigerated storage will work for other vegetable crops, but storage life may be reduced if there is difficulty maintaining cold conditions in the fall.

Ventilation is the movement of conditioned air past or through the produce to remove heat, maintain uniform conditions, and control humidity or condensation. This involves air flow rates and patterns, temperature controls, fans and duct design. Table 5 gives the recommended range of ventilation rates for vegetables.

For bulk storage, air is circulated through the pile by a fan and duct system. Temperature control is usually accomplished by a system of thermostatically controlled dampers which blend cold outside air with recirculated air. Controls should include; (1) a proportioning thermostat, (2) a low limit safety thermostat, (3) differential temperature sensor to prevent ventilation with outside air that is too warm, (4) timer, and (5) damper control motors. The proportioning thermostat controls the damper motors which set the ventilation temperature.

Design of the air handling and distribution system should adhere to sound engineering principles. Ducts should be free of obstruction and adequately sized. Under-pile ducts are spaced 2.4 to 3.6 m (8-12 ft) apart. Storages requiring high humidity should have a high-capacity humidifier as an integral part of the system.

Simpler, low cost ventilation systems, suitable for shorter term or smaller storages can be devised. They can be fans and ducts to circulate air through the pile, and manually operated doors and vents to bring in outside air for cooling.

Refrigeration is required for extended storage beyond the winter months, for early fall storage, and also for most cold crop storages. The refrigeration system should be designed to remove field heat, the heat of respiration, and other heat gains. The system must operate effectively at high humidity , near-freezing conditions, yet minimize moisture loss from the produce. This requires a large coil area, adequate air flow, defrosting cycles and humidification.

In planning refrigerated, or air-cooled storage systems, it is important that the direction of flow of refrigerated or cooled air through the produce be from coldest to warmest produce (usually from back to front). Loading of thestorage, and design of the air flow system, should be done accordingly. That way heat removed from warmer produce does not reheat vegetables that were previously cooled. Condensation caused by warmer air striking cold produce is also prevented.

Refrigeration to about 0°C is required for very long-term storage, for early fall storage and for most cold crop storage. The systems generally available are direct coil units, or "air-washing" systems. Each has its advantages and shortcomings. Cooling coils may be either direct expansion or chilled cooling fluid types. Systems can also be designed which combine outdoor air cooling to reduce refrigeration aerating costs. Refrigeration system design in detail is beyond the scope of this publication, however, it is important to remember to design refrigeration capacity to handle the necessary loads. The system must be able to handle:

- field heat from the produce (this is often the largest cooling load)
- respiration heat of stored fruits or vegetables
- heat gain through walls, ceiling and floor of the storage structure;
- mechanical heat load from lights and meters
- warm air infiltration.

When these cooling loads are taken into account, typical refrigeration capacity for vegetable storages should be:

- cold crops 120-150 w/t (9,000-11,250 BTU/(ton. day)
- potatoes 35-40 w/t (2,600-3,00 BTU/(ton. day).

Table 5. Ventilation rates for vegetable sources.

Produce		Ventilation rate (L/s-tonne) Bulk storage	Ventilation rate (L/s-tonne) Pallet bins
Potatoes	-seed	6-8	10-12
	-table	7-9	
	-processing	8-10	12-15
Beets Cabbage Carrots Parsnip		10-12	15-20
Rutabaga/turnip		8-10	15-20
Pumpkin Squash		15-20	
Onions	-curing	40-50	60-80
	-cold storage	10-15	15-25

Notes:

1. L/s.tonne x 1.92 = cfm/ton.
2. Ventilation rate for palletized storage is closely connected with refrigeration equipment air circulation capacity; thus, may vary considerably depending on the type of equipment.

Plans

Standard plans for commercial sized bulk vegetable storages and storage components,such as walls, doors, and ceiling systems, are available from Alberta Agriculture. The following is a list of storage related plans available through your local district agriculturist office.

Number	Plan Title
*6000	Fruit and Vegetable Storage (planning guide)
6110	Bulk Vegetable Storage Wall (Not Refrigerated)
6111	Bulk Vegetable Storage Wall (Refrigerated)
6112	Refrigerated Pallet Vegetable Storage Wall
6115	Bulk Vegetable Storage Interior Stud Wall
*6119	Hotbed and Coldframe
M-6121	Storage Doors
6311	Braced Rafter Bulk Vegetable Storage
6312	Bulk Potato Storage (1100 tonne, side air plenum)
Q-6313	Bulk Potato Storage (2500 tonne, 2-bin)
M-6319	Walk-in Cooler-Freezer
*6321	Small Rootcellar
*6330	Fruit and Vegetable Storage Insulation

M - Designates a metric plan.

* - This leaflet is the complete plan.

POTENTIAL YIELD AND RETURNS FROM VEGETABLE CROPS

Commercial

The yield and return figures given in the following table are a representative average for all regions of the province where vegetables for the commercial market are grown. Estimated yields, particularly for warm season crops, can be expected to increase in warmer regions of the province. Return figures will vary and depend to a large extent on the marketing channel used, whether wholesale, retail or direct to consumer sales. The figures in Table 6 are based on wholesale trade. Production costs do not include planting, harvesting or storage equipment costs. Management plays an important role in determining profit or loss in any vegetable operation.

Table 6. Potential yield and returns from vegetable crops.

Crop		Average Yield (Tons/ac)	Production Costs ($/ac)	Gross Return ($/ac)
Beans (snap)		4-5	300	1600
Beets		10	400	4000
Broccoli		2	800	1400
Cabbage		10-12	500	2000
Carrots		10-18	400	1800
Cauliflower		6-7	1000	3000
Corn		1000 doz.	460	700
Cucumbers	- slicers	15	1000	8000
	- picklers	7	1300	5000
Onions	- cooking	10-14	1000	3200
Parsnip		7	400	3500
Potatoes		10-12	700	1400
Pumpkin, Winter Squash		15-20	700	3200
Rutabaga		12	340	2800
Zucchini		18	1200	6000

Market garden

Market garden costs and returns vary greatly, depending on types of crops grown, location of market garden and the marketing method used, Most market gardeners do some gate sales and also market at a local farmers market. Generally, there is very little mechanization on a market garden, and therefore there is more labor input which is a costly item and is usually supplied by family members. An estimated $740/acre production cost does not include planting, harvesting, and storage equipment costs. Price received for produce runs 10% or higher than it does at the commercial market.

MARKETING VEGETABLES IN ALBERTA

Vegetable growers in Alberta are generally classed into one of two major groups, (1). market gardener and (2). commercial grower. The method or route used to sell vegetables largely determines the group a producer falls into. Market gardeners are represented by the Alberta Market Gardeners Association. Commercial vegetable growers fall under the jurisdiction of a marketing board which only regulates vegetable sales and not production.

The regulations of the Alberta Fresh Vegetable Marketing Board (AFVMB) apply to all field grown vegetables produced in Alberta with the exception of tomatoes. The AFVMB office is located at 220E - 12 Street A North in Lethbridge, T1H 2J1, phone 327-0447. All sales of produce which go through packers, wholesalers, retailers, restaurants, hospitals, etc. are considered as commercial production and therefore fall under the board's jurisdiction. Consequently, if growers sell their own produce at the farm gate or at a recognized farmers' market they are considered as market gardeners and are exempt from the AFVMB rules and regulations (vegetables sold to processors for freezing or canning are regulated by the Alberta Vegetable Marketing Board). A market gardener sells vegetables direct to the consumer whereas a commercial grower does not and it is the later type of sale that falls under the rules and regulations of the AFVMB. Further, potato sales are not regulated by the AFVMB even though they are a vegetable. Potato growers have their own organization, the Alberta Potato Commission.

The Alberta Fresh Vegetable Marketing Board has a pricing committee that sets minimum prices for fresh vegetables. This committee is composed of growers, packers and wholesalers. Prices are set by telephone conference calls and must be ratified by a majority of AFVMB directors. All prices set are the prices paid by a produce buyer delivered to his warehouse or place of business. All sales must be made on AFVMB invoices which are available from the board office.

The AFVMB deducts a 2% fee from all vegetable sales. The 2% fee is for services provided by the board such as setting minimum prices, operation of the price line, mailing out price lists, lobbying federal and provincial governments on behalf of producers, promoting and advertising Alberta vegetables and other activities.

The one exception to fresh vegetable sales relates to sweet corn. Producers are permitted to sell corn which they have grown without delivering directly to normal channels of trade and without using AFVMB invoices if they obtain a producer vendor licence from the board. Producer vendor licences are available from the board office and a licence must be held for each location where corn will be sold. This may also require obtaining a pedlar's licence from the city, town or municipality where corn will be sold.

All producers of field grown vegetables, by regulation, are required to obtain annually a grower's licence from the AFVMB. There is $70 annual charge for this licence. This still permits the producer to sell produce at the farm gate and at recognized farmers' markets.

Produce entering the commercial market must be graded to meet Canada grade standards. In a competitive market poorly graded produce is hard to sell, therefore, producers are encouraged to grade their produce. Grade standards for each crop are given in Section 5 of this guide.

Often grade standards are closely associated with the container or bag used to hold the produce. In many situations wholesalers will not buy produce from a producer unless it is packed into containers that are accepted by the trade. Counts and weights are an integral part of the vegetable trade and producers are encouraged to check with their produce buyer early in the season and clarify container requirements.

The Alberta Market Gardeners Association (AMGA) is a voluntary organization that endeavors to promote and support the market garden industry. The association operates a toll-free produce information line, supplies gate signs and brochures for the public, plus information packages for market gardeners. Annual membership fees are $50 (full voting) or $25 (associate - nonvoting). The association may be contacted by writing the Alberta Market Gardeners Association, Bag Service 200, Brooks, Alberta TOJ OJO.

Market gardeners can sell vegetables at any of the estimated 110 farmers' markets scattered throughout the province. Alternative marketing methods include pick-you-own and farm gate sales. There are no regulations governing direct-to-consumer vegetables sales except for location. Vendors must obtain a peddlar's licence when selling produce within town or city boundaries. Produce stands on primary or secondary highways in the province are not permitted.

CROP INSURANCE

The Alberta Government in cooperation with the Government of Canada has developed a comprehensive scheme of crop insurance protection for fresh vegetable producers. The Canada-Alberta Crop Insurance Program is administered by the Alberta Hail and Crop Insurance Corporation. Each level of government plus the insured farmers share in the cost of all premiums.

The program provides coverage based on a percentage of the average yield. The coverge is provided to cover the cash costs of preparation, planting and care of a crop. The crops which can be insured under this program are: cabbage, carrots, sweet corn, cooking onions, rutabaga.

To be eligible a minimum of two acres of each crop must be planted. All production from insured acreage must be sold through the Alberta Fresh Vegetable Marketing Board, therefore market garden produce sold directly to the consumer does not qualify for crop insurance coverage.

Deadlines are as follows:

Application: April 30
Election: April 30
Seeding: Varies by crop, contact local District Office
Reports of seeded crops: 10 days after the seeding deadline.
Pre-harvest in section: Notice must be given two days prior to commencement of harvest.
Postharvest claim: November 30
Cancellation: March 31

The program operates on an individual grower basis and consequently the premium is not affected by crop loss claims made by other growers. Each producer stands on his own with this crop insurance program.

An endorsement providing spot-loss protection against hail is also available. Claims must be registered no later than three days after the storm.

To obtain applications or more information contact the local District Office of the corporation listed in the phone book under the Government of Alberta, Alberta Hail and Crop Insurance.

SECTION 2
PEST CONTROL MANAGEMENT

INTRODUCTION TO PEST CONTROL

The most important factor to consider in controlling pests is prevention. Practices such as use of resistant varieties, pest-free transplants and seed, chemical seed treatment, crop rotation and pesticides can be used alone or preferably in combination to prevent pest problems. Crop rotation plays a vital role in weed, disease and insect control by alternating susceptible crops with those that are not affected by specific insects or diseases. In planning crop rotations, growers should consider locating crops in areas where the major weeds can be selectively controlled with herbicides. To facilitate such planning, it would be useful to keep a map which designates common weed species in each field.

Growers who use herbicides that leave residues in the soil must be aware of these residues and plan their crop rotation accordingly. Herbicide drift can also cause damage to crops and a grower should consider possible drift hazard when selecting herbicides.

WEED CONTROL

The chemicals listed for weed control in this publication are those that have been registered for use in Alberta. It is recommended growers obtain a copy of *Guide to Crop Protection in Alberta, Part I - Chemical* for more detailed information on each herbicide referred to in this report. In general, perennial weeds such as Canada thistle and sow thistle cannot be selectively controlled in vegetable crops. Growers should therefore avoid fields that have large patches of perennial weeds. For more information contact the weed control specialist listed on the back cover of this guide.

Chemical weed control should never be used as a substitute for good cultural practices. Escaped or surviving weeds should be removed by timely cultivation when weeds are small to prevent adverse crop competition and weed seed formation. Careful shallow tillage should be used to prevent root injury to the crop. Concentrate on the eradication of persistent perennial weeds by cultural practices or spot treatment with herbicides. Thorough working of the land prior to seeding or planting may kill many small weeds that have just germinated and will assist in forming a good seedbed. A well prepared seedbed enhances uniform crop emergence and also facilitates proper application of herbicides. The modern grower should use chemical weed killers wherever practical as a supplement to good cultural practices. Sanitation or preventing weed seed formation in headlands and shelterbelts is also important to keep the influx of weeds to a minimum.

It is very important to apply the correct dosage when using these chemicals. Herbicides can cause severe injury to the crop if more than the recommended rate is used. DO NOT EXPERIMENT WTIH CHEMICALS OR MIXTURES WHICH ARE NOT RECOMMENDED. If more than a permitted amount of herbicide residue is found in the crop, the entire crop can be seized without compensation to the grower.

Contact herbicides

These materials kill all above-ground foliage on contact. Contact herbicides do not move systemically through the plant, therefore thorough spray coverage is critical for good results. Contact herbicides can be used with the stale seedbed technique. A stale seedbed involves the following steps: a) preparing a seedbed in advance of seeding in order to stimulate weed emergence, b) seeding is done without reworking the seedbed and c) a nonselective contact herbicide is applied to "burn off" emerged weeds before the crop itself has emerged. Gramoxone (paraquat) 200 g/L is registered for the stale seedbed technique for beans, red beets, carrots, cole crops, corn, cucumbers, onions, peas, potatoes and rutabagas (turnips). Apply Gramoxone at 1.1 to 2.2 L/acre (2.75 to 5.5 L/ha) in 120 to 445 L of water per acre (300 to 1100 L/ha) no later than three days before crop emergence. Use the higher rate when weeds are above 5 cm in height, and higher volumes of water on dense weed growth. Gramoxone does not provide any residual weed control.

Inter-row weeding with a contact herbicide such as Gramoxone can be used as a rescue operation where previous methods of weed control have failed. The herbicide is directed between the crop rows onto the emerged weeds. Use special low-pressure applicators such as dribble bars or vibra jet nozzles equipped with shields to prevent wetting the crop. This technique of weeding with Gramoxone is registered for use on cucumber, lettuce, onion, potato and tomato crops.

Preplanting treatments

Preplanting treatments are applied before the crop is sown or planted. These herbicides generally kill weed seedlings soon after germination. Most herbicides used for these treatments must be thoroughly incorporated into the soil by cultivation such as disking or rotovating immediately after application.

Selective preemergence herbicides

These materials prevent emergence and provide early kill of many weed seedlings without reducing crop stand. This type of material should be applied immediately after seeding or at least before emergence of the crop. If these materials are applied after weeds have emerged the kill is usually poor. Best results are obtained with preemergence herbicides when conditions for weed seed germination are good. Rainfall or irrigation water applied after application of herbicide is required to activate these herbicides.

Selective postemergence herbicides

These chemicals are applied after the crop plants are up, or after the crop has been transplanted. Weed seedlings must be correctly identified in order to select the proper herbicide. Applied as directed, the weeds can be killed without injury to the crop. The weeds should be small for best results. Good growing conditions usually enhance weed control.

CAUTION

Spray drift can damage or destroy susceptible crops and shrubs for a great distance from the sprayer. Do not use 2,4-D, MCPA or dicamba or ester formulation of 2,4-D or MCPA herbicides near susceptible crops such as beans and tomatoes. Take into consideration both the direction and speed of the wind when applying this type of herbicide. Use low pressures whenever possible; 205-240 kPa (30 to 35 lb/sq in.) is usually enough. DO NOT USE THE SAME SPRAYER FOR APPLYING 2,4-D AND SIMILAR HERBICIDES AS YOU USE FOR SPRAYING INSECTICIDES AND FUNGICIDES. Drain thoroughly and wash out the sprayer immediately after use. DO NOT MIX DIFFERENT HERBICIDES OR HERBICIDES WITH OTHER PESTICIDES, FOLIAR FERTILIZERS, SURFACTANTS, OR DETERGENTS UNLESS IT IS RECOMMENDED BY COMPETENT AUTHORITIES.

INSECT CONTROL

Specific recommendations are listed under each crop in the production recommendations section of this publication. Growers wishing more detailed information should contact one of the insect control specialists listed on the back cover of this guide.

Following are general guidelines for controlling insects:

1) Examine plants frequently throughout the growing season to detect insect infestations in their earliest stages. The best control is achieved when insecticides are applied to the young stages of insects.

2) On some crops, one insecticide will control more than one insect pest. Choose an insecticide to control the main insect pest, then see whether or not it will control the others.

3) Some of the insecticide recommendations in this guide are expressed in ranges. Use the lower rates and volumes when plants are small; use the higher rates and volumes as the size of the plants increase. For best results, spray both sides of the leaves.

Preplanting soil treatment using lorsban 4C*

Crop	Cutworm	Type of Rate	Crop
broccoli brussels sprouts cabbage cauliflower celery chinese cabbage cucumber green pepper potato rutabaga tomato	dark-sided red-backed	1.1 L/ac (2.8 L/ha)	Apply once in 80-160 L/ac (200-400 L/ha) of water 3 to 7 days before planting or transplanting. DO NOT incorporate. Application should also be made to a 15 m (50 ft) strip into nearby crop or rows.

*See under individual crops (Section 5) for alternative control products.

Postplanting treatment (seeding treatment) using lorsban 4C*

Crop	Type of Cutworm	Rate	Remarks
bulb onion carrots	dark-sided red-backed	1.1-2.2 L/ac (2.8-5.6 L/ha)	Apply in 80-160 L/ac (400 L/ha) of water at seeding (2-5 leaf) stage when first damage appears.
broccoli brussels sprouts cabbage cauliflower celery chinese cabbage corn cucumber green pepper potato rutabaga tomato	dark-sided red-backed	0.6-1.1 L/ac (1.4-2.8 L/ha)	

Follow label directions for intervals between the treatment and harvest.

*See under individual crops (Section 5) for alternative control products.

4) Practise crop rotation whenever possible. Growing crops that are not susceptible to the same pests prevents build-up of serious pests.

5) Practise sanitation (destruction of crop refuse and good weed control) to help prevent insect pests from completing some stage of their life cycle or from being protected during the winter.

Control of general insect pests in vegetables

Cutworms

The main problem species is the red-backed cutworm, but other cutworm species can cause damage in localized areas. If the field has a history of infestation, a preplant soil treatment should be used. If the plants are already growing, a seedling treatment when damage appears will provide control.

Effective control is dependent on the proper timing of insecticide application. Many insecticides have short residual activity and break down quickly in sunlight. Most species of cutworms go into the soil during the day and come out to feed at night. Thus, most effective control is obtained by treating in late afternoon or early evening just before the cutworms come out to feed. Lorsban 4C is particularly effective when the soil is moist; higher rates may be necessary under dry conditions.

Slugs

Metaldehyde and Mesurol are the only slug control products registered in Canada. Where slugs are a problem, treatment should be applied while plants are in the seedling stage. Poisoned baits are most effective when applied early in the season before slugs begin feeding on mature plants. Apply commercially available baits in the evening around the base of plants and to the edges of headlands.

Wireworms

Wireworms are most likely to be a problem the first two years after sod breaking. They can be controlled by planting treated cereals for two years, then growing vegetables, or by using a lindane seed treatment on large seeded vegetables such as peas, beans and corn.

DISEASE CONTROL

Compared with major production areas where vegetable production is often more intense and where humid conditions exist, Alberta is relatively free of serious diseases on vegetable crops. However, severe disease outbreaks can occur and growers should be familiar with preventative and control measures. For more detailed information on disease control on a specific crop, contact one of the disease control specialists listed on the back cover of this guide.

A special section is included here on the control of disease before and shortly after germination. Seed treatments, sterilization of transplant soil and equipment, and disinfection of storage and associated equipment can all play an important role in the prevention of diseases both in the field and in storage.

Specific disease control recommendations are listed in the production recommendations section of this publication. The following are general recommendations for controlling diseases:

1) Prevention of damping-off through use of fumigated or steamed seed beds, pesticide soil drenches, proper cultural practices (especially watering), and seed treatment fungicides.

- Hot-water treatment of seed for elimination of certain seed-borne diseases.
- Rotation of crops so that those susceptible to the same diseases are not planted year after year in the same field.
- Sanitation (destruction of crop refuse) to reduce the probability of diseases in subsequent crops.
- Isolation, roguing, and control of insect vectors to minimize the spread of virus diseases.
- Use of resistant varieties.
- Use of fungicides and bactericides for prevention of foliar diseases.

Seed treatment

Most seeds must be treated with a fungicide to protect them against decay in the soil and damping-off as young seedlings. In addition to this, certain kinds of seeds require special treatment to kill any parasitic fungi or bacteria that may be present in or on the seed, unless the seed has already been treated by the seed company. Seed treatment with an insecticide-fungicide mixture should be done not more than three months before planting.

For methods of application and quantities to use, see label directions on the pesticide container. Nearly all seed treatments recommended are made up in two ways: 1) for dust treatment 2) for slurry. The slurry treatment is safer for the operator and gives better coverage.

To ease the flow of seed through the drill or planters, add 30 g (1 oz) of graphite per 20 to 25 kg (50 lb) of seed.

NOTE--SEED TREATED WITH EITHER FUNGICIDES OR INSECTICIDES MUST NOT BE USED FOR FOOD OR FED TO LIVESTOCK.

Seed treatment with fungicides and insecticides does not necessarily ensure freedom of the plants from all diseases and insects, but they may be an effective means of prevention.

Chemical seed treatment

All vegetable seeds should be treated with Thiram or Captan fungicide to reduce losses from seed decay and damping-off. In addition, large, seeded crops such as beans, corn, peas and cucumbers can be treated with lindane insecticide to control wireworms or diazinon to control seed maggots. When purchasing commercial seed stock, be sure to specify what seed treatment is required.

Hot water seed treatment

Place seed in a cheesecloth of ample size, wet seed and bag with warm water. Soak seed of cabbage, brussels sprouts, pepper, spinach, tomato and eggplant for 25 minutes in water maintained at 50°C; cauliflower, kohlrabi, kale and summer turnip for 15 minutes at 50°C; celery for 30 minutes at 48°C, rutabaga for 20 minutes at 50°C. Then spread seeds out to dry on clean cheesecloth. USE AN ACCURATE THERMOMETER. Stir the water and bags of seed constantly to secure a uniform temperature within the bag. Before sowing, treat and dry seed with a seed protectant.

Damping-off

This disease takes several forms. Seed can rot in the soil, seedlings can die before they come up, or seedlings can topple over after emergence. Stem tissues at the soil-line can become water-soaked and brown or black. Shrivelling of affected tissue may follow. Wirestem of cabbage is a form of damping-off, but seedlings may fall over in this case.

To control damping-off, follow these recommendations:

1) Disinfect soil with Formalin (formaldehyde), steam, dry heat, methyl bromide*, chloropicrin*, Vorlex, Vapam, Basamid or use Captan 7.5 D at 1.2 kg/100 m^2 (2.5 lb/1000 sq ft) mixed into the top 7.5-10 cm (3-4 in.) of seedbed. For bulk soil, use 1.7 kg (3.8 lb) Captan 7.5D per 10 m^3 (13 cu yd).
2) Treat seed with fungicides.
3) Provide good ventilation.
4) Water in the morning.
5) Don't sow seeds too thickly.
6) Keep humidity low.

*CAUTION, VERY TOXIC.

If damping off appears, drench seedbeds with a water solution of one of the following fungicides: No Damp 2.5% SN at 15 mL/L (0.5 fl oz/1.75 gal), Vitavax-Captan 30 W at 2.5 g/10L (0.5 oz/10 gal) or Captan 50 W at 25 g/10L (0.5 oz/gal). Apply enough solution to wet the soil to a depth of 7.5-10 cm (3-4 in.).

Sterilization and fumigation of soil and equipment

Greenhouse soils, seedbeds, gardens

Soil sterilization or fumigation has an important place in controlling damping-off and other diseases, insects, weeds and nematodes in both seedbeds and greenhouses, and occasionally in small vegetable gardens.

The following rules must be followed to achieve satisfactory results:

- The soil temperature at a 15 cm (6 in.) depth must be 13°C or higher for successful treatment with chemicals.
- Soil must be in a loose condition so that penetration is complete. Sods, lumps, and organic materials must be thoroughly broken up.
- If organic materials (manure, compost, etc.) are to be used, they must be incorporated before treatment so that recontamination does not occur.
- The soil must be moist but not wet.

When soil is sterilized with steam or fumigated with chemicals, the number of soil microorganisms is greatly reduced for the first few days, then it rises and eventually equals that of untreated soil. The sterilizing or fumigating process destroys a large part of the dense population of soil microbes, and the first organisms to return after treatment meet no severe competition. Thus, if plant pathogens are among the first to recolonize the soil, they develop rapidly and can cause severe losses. It is therefore important to the grower that every effort be made to prevent disease organisms from gaining entrance to the soil.

Pathogens can gain entrance to the soil by:

- splashing during watering or by rain
- infected cuttings
- soil in water hose
- infested containers
- infested tools and equipment
- grower's hands and footwear
- placing containers on the ground
- unsterilized covers
- infected plants or seeds.

The following methods can be used to sterilize greenhouse soils and seedbeds.

Steam- Controls all disease organisms, insects, nematodes, and most weed seeds. Steam sterilization is accomplished by passing large quantities of steam into the soil until the temperature becomes sufficiently high at the desired depth. For this purpose a steam boiler is required. A greenhouse steam boiler or a portable unit of about 200 kW (20 hp) may be used. For successful sterilization, the coldest part of the soil mass must be held at 82°C (180°F) for at least 30 minutes.

Formalin* - Commercial Formalin containing 37 to 40% formaldehyde is effective against damping-off and various other disease organisms. Areas where sterilized or fumigated soil is dumped in bulk piles should previously have been wetted down with a solution containing 625 mL of formaldehyde in 25 L of water (1 pt to 5 gal). The same solution can be used for bulk soil or beds applying 80 L of solution per m^3 of soil or 25 L/m^2 of bed (13.5 gal solution/cu yd of soil or 4/5 gal/ yd^2 of bed). The soil should then be covered with a plastic sheet for 48 hours. An aeration period of about 2 weeks with frequent cultivation or stirring in the interval is required to allow the gas to escape. Seeding may safely be done when no odor of Formalin remains.

Methyl Bromide* - Apply at 45 to 90 g/m^2 (1.3 to 2.7 $02/yd^2$) methyl bromide (98% LI) under a plastic cover and according to the manufacturer's directions. It controls most nematodes, most weed seeds and most disease organisms, but not verticillium wilt. (WARNING--Where celery is to be seeded, soils in cold frames or for filling flats should be test seeded with celery well in advance of normal seeding time to ensure bromine residues will not affect germination and growth of celery.)

Basamid - Basamid (98% G) controls nematodes, root diseases, soil insects and some weeds. Distribute 30 to 50 g/m^2 (1 to 1.5 oz/yd^2 or 130 to 200 kg/ac (325 to 500 kg/ha) evenly on the soil surface. This can be done by hand (with rubber gloves) or by means of a fertilizer spreader. Incorporate to a depth of 15 to 20 cm (6 to 8 in.) and seal the soil by irrigation and packing or by covering with plastic sheets. The soil must be aerated before seeding can take place.

To use Basamid in soil mixes, incorporate 200 g/m^3 (200 oz/1000 ft^3) of soil. NOTE--The amount of time required for fumigation and aeration of the soil depends upon the soil temperature. For further information, contact the vegetable specialist listed on the back cover of this publication or follow manufacturers' directions.

Chloropicrin*, Chloropicrin mixtures*, Vorlex, Vapam. Effective for the control of damping-off organisms, verticillium and fusarium wilts, some weed seeds, some nematodes, and other soil pests. Follow manufacturers' directions.

Flats, benches, containers, tools.

To prevent spread of disease organisms and reinfestation of treated soils, all pots, flats, bins, beds, and tools should be disinfected using the following methods:

1. Steam. Items to be steamed should be placed on a bench, or stacked and covered with a tarpaulin, beneath which steam is released to maintain a minimum temperature of 82°C (180°F) for at least 30 minutes.
2. Formalin*. Used flats, etc. should first be cleaned of excess soil, then dipped for 5 minutes in a solution containing 625 mL of formaldehyde in 25 L of water (20 oz in 5 gal) or sprayed thoroughly with a solution containing 1 L of formaldehyde in 25 L of water (32 oz in 5 gal). Treated flats and benches should be kept wet by sprinkling with water for 4 to 5 days until all odor of formaldehyde has gone. Tools may be dipped in a solution containing 1.25 L of formaldehyde in 25 L of water (2 pt in 5 gal) and then rinsed in clean water and used immediately.
3. Methyl bromide*. Empty flats, pots, etc., may be stacked, covered with plastic and fumigated with 160 to 325 g/m^3 (1 to 2 lb/100 ft^3) in the same way as if they were filled with soil.

Root cellars, storage buildings, bins.

Where storage diseases have occurred, clean out the storage area removing all soil, rotted vegetable matter, etc., and drench the floor and walls with one of the following chemicals:

Copper sulphate (bluestone) at 5 to 7.5 kg/500 L of water (10-15 lb/100 gal water). Do not use bins until they are dry.

Formalin* (37-40% formaldehyde) at 2.5 L/100 L of water (2.5 gal/100 gal water). Use gas mask in closed areas. Close storages for 24 hours after treatment and then air out until odor is gone.

Quarternary ammonium compounds may be used according to the manufacturer's directions, provided the areas to be treated are first cleaned and washed.

*CAUTION, VERY TOXIC.

PERSONAL SAFETY IN PESTICIDE USE

The usefulness of pesticides lies in their ability to interrupt the life processes of plant and animal pests. However, these chemicals can have fatal effects on the life processes of humans and other animals. BE OVERLY CAUTIOUS AND HANDLE ALL PESTICIDES WITH RESPECT. The use of agricultural chemicals is increasing annually, both in total acreage treated and in the number of new compounds being introduced for the control of various pests. As a result, farmers are being exposed to a greater quantity of pesticides, some of which may be deadly. Growers applying pesticides should have proper protective clothing and use a respirator to minimize exposure to pesticides during mixing and application. Safe storage and safe disposal of surplus chemicals are required to avoid accidents.

Each person involved in the handling and application of pesticides must be vigilant and constantly aware of the seriousness of swallowing or absorbing even a tiny amount of these chemicals by the body. Farmers, the major pesticide users, are exposed to pesticides at various times. The major risk occurs during handling, storage and clean-up operations. It is important to know that chemicals can get on and into the body by breathing, by eating and by absorption through skin and eyes, or injection through the skin.

Please consult the publication **Guide to Crop Protection in Alberta - Part 1** Chemical for detailed information on protective devices for use when handling or applying pesticides.

Emergency telephone numbers

Poisonings

There is only one Poison Control Center in Alberta (1-800-332-1414). Calgary and area residents may dial the Center's local number (270-1414). This Center should be contacted in the event of a pesticide poisoning emergency.

Environment Emergencies
(spills, water contaminations, etc.

These incidents should be reported to Alberta's Pollution Emergency Response Line (1-800-222-6514). This is a toll-free 24 hour emergency line.

Re-entry to treated areas

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. Follow the label recommendations. Where no label warning is provided, the following minimum intervals are recommended.

24 Hours	..................48 Hours................		
Lannate	Birlane	Guthion	Systox
Phosdrin	Dasanit	Meta-Systox R	Temik
Supracide	Furadan	Monitor	

Storage of pesticides

Pesticides should always be stored in a cool, dry, locked and well ventilated area away from food and drink used for human or animal consumption. It is advisable to select a building or part of a building which is separated from human and animal quarters. The building should be posted with a warning sign, "Chemical Storage--Authorized Persons Only" in block letters, clearly visible. It should be built of fire resistant materials. Pesticide wastes should drain to a disposal system specifically designed for pesticides. Protective clothing, a respirator and a first aid kit should be available for the storage area but kept separately to prevent contamination.

Do not remove more material from storage than you can use in a day and return unused quantities immediately after completion of spray operations.

Pesticides should always be stored in the original container no matter how small a quantity requires storage. If a container is damaged and losing its contents, repack and label the package properly. Herbicides should always be stored separately from other types of pesticides and fertilizers to prevent cross contamination or danger of fire or explosion.

Decontamination and disposal

Decontamination

Decontamination may be necessary if you have been exposed to concentrated pesticide material as it comes from the can before mixing. Contaminated clothing must be removed and stored in a plastic bag until it can be washed. Wash the contaminated area rapidly and thoroughly with detergent and water. Rinse thoroughly. Wash again and rinse. Now wash the contaminated area with rubbing alcohol to remove any remaining pesticides.

If a pesticide is spilled inside a building, you may need to wear protective clothing and probably a respirator. LET SOMEONE ELSE KNOW WHAT YOU ARE DOING AND HAVE THEM STAND BY OUTSIDE THE BUILDING. Check the label again if you do not remember details about the chemical. Begin by soaking up excess liquid with sawdust, rags, powdered clay, dirt or commercial cleaning compounds. Sweep up material and put it into a plastic bag for disposal by burning or by burying it in at least 45 cm (18 in.) of soil in an area that will not contaminate the sewage disposal system or ground outside the building. Put the contaminated dustpan and broom or brush into a plastic bag and keep for use with pesticides only. If the spill occurs outside on the ground, cover with soil and allow the pesticide to soak into the ground. DO NOT use this as a method of disposing of excess amounts of pesticides.

Disposal of containers

Empty containers should be delivered to a designated pesticide container disposal site. Contact your agriculture fieldman for the locations of pesticide container disposal sites in your county.

Disposal of surplus mixed herbicides

The methods developed to handle this problem are inadequate. For practical purposes the best answer is to try not to mix more than you need. When this is not possible first priority should be given to spraying out the pesticide in waste areas, headlands or fence rows, unless it is expected that serious damage will occur. Strategies should be developed by which the waste pesticide can be used advantageously. If this method of disposal is not feasible, then dump the waste pesticide in a designated disposal pit. The pit should be on high ground where water will not collect and present a danger of draining or leaching into ground water.

RELATIVE TOXICITY OF PESTICIDES

Lethal Dose (LD_{50})

The LD_{50} of a pesticide is the single dose that kills 50% of a group of animals which are given the chemical by mouth (orally). It is measured as the amount, in milligrams, of chemical given per kilogram of body weight of the animal (mg/kg). THE LOWER THE LD_{50}, THE MORE DANGEROUS IS THE PESTICIDE.

The following table relates the oral LD_{50} (mg/kg) of a pesticide to its toxicity.

less than 50 high toxicity	500-1000 moderate toxicity
1000-2500 low toxicity	greater than 2500 very low toxicity

Human exposure to pesticides

Farmers may be exposed to pesticides when they are (a) handling and mixing powder, dusts and granules; (b) opening containers of emulsifiable concentrates (E.C.); (c) pouring concentrated liquids into the sprayer tank; and (d) spraying.

Pesticides may enter the body through the skin (dermally) and mouth (orally), and by inhalation. Penetration through the skin is the most common way and occurs when the concentrated chemical is being handled, or the dilute material is being sprayed without proper safety clothing. Immediate illness may occur once enough chemical enters the body.

Although many pesticides do not penetrate the skin, they may still cause skin problems such as redness, blisters, or dry scaliness that may lead to serious skin eczema and dermatitis. Pesticides may enter the body through cuts, scrapes and bruises which should be covered with band-aids or bandages. Eyes are very sensitive to pesticides. They can be exposed to vapor or fumes, spray drift, or accidental spills and splashes when containers of liquid concentrates are being opened or when the concentrated chemical is being poured into the sprayer tank.

Pesticides can also enter through the mouth when a farmer eats or smokes with contaminated hands or when he licks his lips. Children may be poisoned if they drink pesticides stored in pop bottles. All pesticides should be stored in their original containers in a securely locked area out of reach of children.

Pesticides can also enter the body through the inhalation of fumes, dusts, or spray mists. In the case of fumes and extremely fine particles of dust or spray, complete absorption of chemical by the lungs can occur and the hazard is high.

Standard safety precautions

Whenever working with pesticides, wear standard protective clothing: long sleeve shirt, full length pants, coveralls, rubber boots, and cap.

In addition to the standard clothing, use common sense to decide what extra protection is needed for a particular job. Sometimes the label on the pesticide container gives details of extra precautions required. Extra protective equipment is rubber or neoprene gloves, goggles, respirators, and gas masks.

Coveralls: Two types of coveralls are available: reusable and disposable. Reusable cotton coveralls are washable and can be used again and again. Disposable paper coveralls are usually more comfortable in hot weather and are lightweight. If they become damaged or severely contaminated, they should be discarded. Wash coveralls after every pesticide application or when contaminated.

Rubber boots: Do not wear leather boots and sneakers as they absorb pesticides and are difficult to clean. The legs from the coveralls should be outside the top of the boots to prevent spills and splashes from running into the boots. If the inside of the boots is contaminated, it should be washed out immediately.

Caps: Prevent powders, dusts, or spray mists being deposited on the hair or scalp and be absorbed into the body.

Gloves: These are required when handling, mixing, or pouring concentrated pesticides. Rubber or neoprene are recommended but they should be washed very soon after use as the chemical may penetrate in to the material. Do not wear leather or cloth gloves. These materials soak up the chemical and become a source of continuous contamination. Gloves with holes should not be worn. The sleeves of the coveralls should be worn outside the gloves to prevent spills and splashes from running into the gloves.

LIST OF PESTICIDE TRADE NAMES, ACTIVE INGREDIENT, MANUFACTURER, CHEMICAL CLASSIFICATION AND MODE OF ACTION

The class of chemical to which a pesticide belongs and its mode of action is designated as follows:

Chemical Classification	
C	carbamate
I	inorganic
OP	organophosphate
D	dithiocarbamate
OC	organochlorine
OH	organohalogen
N	dinitro
T	triazine
U	methyl urea
M	miscellaneous
#	designates a very toxic pesticide

Mode of Action	
C	contact
S	stomach
Sy	systemic
F	fumigant

Herbicides

Trade Name	Active Ingredient	Manufacturer	Chemical Class.
Aatrex	atrazine	Chipman Inc.	T
		Ciba Geigy Canada Ltd.	U
Afolan F	linuron	Hoechst Canada Ltd.	
Alanap 3	alanap 3	Uniroyal Chemical	
Amiben	chloramben	Union Carbide	
Amitrol-T	amitrole	Union Carbide	
Basagran	bentazon	BASF Canada Inc.	M
Basfapon	dalapon	BASF Canada Inc.	M
Bladex	cyanazine	Ciba Geigy Canada Ltd.	T
2,4-D	2,4-D	Uniroyal Chemical	
		Dow Chemical Canada	
CIPC	chloropropham	StanChem	M
Dalapon	dalapon	Dow Chemical Canada	M
Dowpon	dalapon	Dow Chemical Canada	M
Dowpon M	dalapon	Dow Chemical Canada	M
Dual	metolachlor	Ciba Geigy Canada Ltd.	
Dyanap	dinoseb + naptalam	Uniroyal Chemical	
Eptam	EPTC	Chipman Inc.	C
Eradicane 8-E	EPTC + R25788	Chipman Inc.	C
Fusilade	fluazifop-butyl	Chipman Inc.	M
Goal	oxyfluorfen	Rohm & Haas Canada Ltd.	
Gramoxone #	paraquat	Chipman Inc.	M
Hoe-Grass	diclofop-methyl	Hoechst Canada Inc.	
Kil-Mor	2,4-D, mecoprop, dicamba	Ciba Geigy Canada Ltd.	
Laddok	bentazon + atrazine	BASF Canada Inc.	MT
Lexone	metribuzin	Dupont Canada Inc.	T
Lorox L	linuron	Dupont Canada Inc.	U
MCPA-sodium salt	sodium salt	Dow Chemical Canada	

Herbicides (continued)

Trade Name	Active Ingredient	Manufacturer	Chemical Class.
Pardner	bromoxynil	May & Baker Canada Inc.	OC
Patoran	metobromuron	BASF Canada Inc. Ciba Geigy Canada Ltd.	U
Poast	sethoxydim	BASF Canada Inc.	M
Prefar (4.8 EC)		Stauffer Chemical Co.	
Primextra	metolachlor + atrazine	Ciba Geigy Canada Ltd.	M
Princep Nine-T	simazine	Ciba Geigy Canada Ltd.	
Pyramin	pyrazon	BASF Canada Inc.	M
Reglone	diquat	Chipman Inc.	M
Rival	trifluralin	Hoechst Canada Inc.	N
Ro-Neet - 7.2 E	cycloate	Chipman Inc.	
Roundup	glyphosate	Monsanto Canada Ltd.	M
Sencor	metribuzin	Chemagro Ltd.	T
Simadex	simazine	Ciba Geigy Canada Ltd.	T
Sodium TCA	sodium salt	Hoechst Canada Inc.	
Sutan +	butylate	Stauffer Chemical Co.	C
Sweep	paraquat	Chipman Inc.	M
Torch	bromoxynil	Union Carbide	OC
Treflan	trifluralin	Elanco Products Div.	N
Triflurex	trifluralin	Makhteshim-Agan	N
Tropotox	MCPB	May & Baker Canada Inc.	OC
Tropotox Plus	MCPB + MCPA	May & Baker Canada Inc.	OC

Insecticides/Fungicides

Trade Name	Active Ingredient	Manufacturer	Chemical Class	Mode of Action
Ambush	permethrin	Chipman Inc. Chemagro Ltd.	M	C,S
Basudin	diazinon	Ciba Geigy Canada Ltd	OP	C,S
Belmark	fenvalerate	Ciba Geigy Canada Ltd.	M	C,S
Benlate (fungicide)	benomyl	Dupont Canada Inc.	M	
Birlane #	chlorfenvinphos	Stafford Chemical Ciba Geigy Canada Ltd.	OP	C
Botran (fungicide)	dichloran	Tuco Products Co.	OH	
Bravo (fungicide)	chlorothalonil	Diamond Shamrock	OC	
Captan (fungicide)	captan	Later Chemicals	M	
Copper-Fixed (fungicide)	copper oxychloride		I	
Cygon	dimethoate	Cyanamid Canada Ltd. Chipman Inc.	OP	C,S,Sy
Cythion	malathion	Cyanamid Canada Ltd.		
Dasanit	fensulfothion	Chemagro Ltd.		
Decis	deltamethrin	Hoechst Canada Ltd.	M	C,S
Diazinon	diazinon	Ciba Geigy Canada Ltd.	OP	C,S
Dibrom	naled	Chevron Chemical Canada	OP	C,S

Insecticides/Fungicides (continued)

Trade Name	Active Ingredient	Manufacturer	Chemical Class.	Mode of Action
Difolaton (fungicide)	captafol	Chevron Chemical Canada	M	
Dipel	Bacillus	Abbott Laboratories thuringiensis	M	S
Di-System #	disulfoton	Chemagro	OP	Sy
Diathane M-22 (fungicide)	maneb	Dupont Canada Inc.	D	
Dithane M-45 (fungicide)	mancozeb	Rohm & Haas Canada Ltd.	D	
Dithane M-45 (fungicide)	zineb	Rohm & Haas Canada Ltd.	D	
Dyrene (fungicide)	anilazine	Chemagro Ltd.	M	
Furadan #	carbofuran	Chemagro Ltd.	C	C,S,Sy
Guthion #	azinphos-methyl	Chemagro Ltd.	OP	C,S
Karathane (fungicide)	dinocap	Rohm & Haas Canada Ltd.	D	
Kelthane (miticide)	dicofol	Rohm & Haas Canada Ltd.		
Lannate #	methomyl	Dupont Canada Ltd.	C	C,S,Sy
Lagon	dimethoate	Later Chemicals		
Lorsban	chlorpyrifos	Dow Chemical Canada Ltd.	OP	C,S
Malathion	malathion	Cyanamid Canada Ltd.	OP	C,S
Manzate-D (fungicide)	maneb	Dupont Canada Ltd.	D	
Manzate-200 (fungicide)	mancozeb	Dupont Canada Ltd.	D	
Metasystox-R #	oxydemeton-methyl	Chemagro Ltd.	OP	C,Sy
Methoxychlor	methoxychlor	Dupont Canada Ltd.	OC	C,S
Monitor #	methamidophos	Chemagro Ltd.	OP	C,S,Sy
Parathion	parathion	Cyanamid Canada Ltd.	OP	C,S
Phosdrin #	mevinphos	Ciba Geigy Canada Ltd.	OP	C,Sy
Pirimor	perimicarb	Chipman Inc.	C	C,F
Polyram (fungicide)	metiram	BASF Canada Ltd.	D	
Pounce	permethrin	Chipman Inc. Chemagro Ltd.	M	C,S
Ridomil MZ (fungicide)	metalaxyl	Ciba Geigy Canada Ltd.		
Rotenone	rotenone	Wilson's Laboratory Inc.	M	C,S
Sevin	carbaryl	Union Carbide	C	C,S
Sys-Tem #	dimethoate		OP	
Systox	demeton	Chemagro Ltd.	OP	C,Sy
Thiodan #	endosulfan	Chipman Inc. Hoechst Canada Inc.	OC	C,S
Thuricide	Bacillus	Sandox Inc. thuringiensis	M	S
Zineb	zineb	FMC Canada Ltd.		

STORAGE AND SHELF LIFE OF PESTICIDES

Most pesticides are designed to last for two years or longer when properly stored by the user. Proper storage involves cool, dry conditions. Wettable powders stored at cool temperatures and low humidities will be stable for at least this period of time. Bags should be tightly sealed during storage. Liquid formulations generally do not last as long as powders, but if kept sealed and away from temperature extremes, should last for two years. It is a good idea to observe this two year period and purchase only sufficient material to use within this time.

The following list provides further information on storage of some specific pesticides.

Pesticide	Shelf Life	Minimum Storage Temperature	Comments
Insecticides			
Carbaryl	several years	0°C	Flowable formulations may settle out.
Diazinon	5-7 years	-18°C	Keep liquids tightly sealed; granulars and powders dry.
Di-Syston#	2 years	-18°C	-
Guthion#	2 years	0°C	-
Malathion	indefinite	-18°C	-
Metasystox R#	2 years	-18°C	-
Methoxychlor	indefinite	0°C	-
Fungicides		(spray concentrated)	
Benomyl	2 years		*Keep dry and tightly sealed.
Captan	3 years	5°C	-
Herbicides		(flowable)	
Dacthal	at least 2 years	*	-
Roundup	at least 2 years	0°C	-
Kerb	at least 2 years	*	-
Gramoxone#	indefinite	0°C	very stable
Treflan	3 years	*	store below 27°C

*Most dry formulations have no minimum storage temperature.

COMPATIBILITY CHART FOR SPRAY CHEMICALS

☐ = Generally compatible
X = Incompatible
0 = Not usually mixed or compatibility not known.
WP = Use Wettable Powder forms
D = Decomposes on standing, use immediately.
C = Generally satisfactory but occasionally damage occurs.

	Ambush	Basudin (diazinon)	Benlate, Easout	Birlane	Botran	Bravo	Captan, Difolatan	Coppers (fixed)	Cygon, Rogor, Dimethoate	Dasanit	Dibrom, Phosdrin	Dipel, Thuricide	Di-Syston	Dithane M-22, M-45	Du-ter	Dyfonate	Ethion	Furadan	Guthion	Kelthane	Lannate	Malathion	Manzate-D,200	Metasystox-R	Methoxychlor	Monitor	Parathion	Pirimor	Polyram, Zineb, dithane Z-78	Sevin	Systox	Thiodan
Ambush	●	0		0	0			0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0			0	0	0
Basudin (diazinon)	0	●		0				D		0	0		0			0		0			0	0		0		0		0			0	
Benlate, Easout			●	0				C																		0	C					
Birlane	0	0	0	●	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Botran	0		0	0	●		0	X	0	0	0		0	WP	0	0	WP	0	0	WP	C	WP	WP	WP	WP	0	WP	0	WP		WP	
Bravo				0		●												0		0	C					0		C				
Captan, Difolatan				0	0		●	0		0			0	0		0	WP	0		WP		WP	0	WP	WP	0	WP		0		WP	WP
Coppers (fixed)	0	D	C	0	X		0	●		0			0	D		0	0	0					D			0		0	D	X		
Cygon, Rogor, Dimethoate	0			0	0				●	0								0			0					0		0				
Dasanit	0	0		0	0		0	0	0	●	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dibrom, Phosdrin	0	0	X	0	0					0	●							0				0		0		0		0			0	
Dipel, Thuricide	0			0	0					0		●	0													0						
Di-Syston	0	0		0	0		0	0		0		0	●	0	0			0		0	0	0	0	0	0	0		0	0	0	0	
Dithane M-22, M-45				0	WP		0	D		0			0	●		0	0	0					0		WP	0		0	0			
Du-ter	0	WP		0	0				0				0		●			0	0							0				WP		0
Dyfonate	0	0		0	0		0	0		0				0		●		0		0	0	0	0	0	0	0	0	0	0	0	0	
Ethion	0			0	WP		WP	0		0				0			●	0		0		0	0	0	0	0	0	0	0	0	0	
Furadan	0	0		0	0		0	0	0	0	0		0	0		0	0	●	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guthion	0			0	0					0								0	●							0						
Kelthane	0			0	WP	0	WP			0			0			0	0	0		●						0		0				
Lannate	0	0		0	C	C			0	0			0			0		0			●					0						
Malathion	0	0		0	WP		WP			0	0		0			0	0	0				●				0		0				
Manzate-D,200				0	WP		0	D		0			0	0		0	0	0					●		WP	0			0			
Metasystox-R	0	0		0	WP		WP			0	0		0			0	0	0						●		0					0	
Methoxychlor	0			0	WP		WP			0			0	WP		0	0	0					WP		●	0		0	WP			
Monitor	0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	0	0	0	●	0		0	0	0	0
Parathion	0		C	0	WP		WP			0						0	0	0								0	●	0				
Pirimor		0		0	0	C		0	0	0	0		0		0	0	0	0		0		0			0		0	●				
Polyram, Zineb, dithane Z-78				0	WP		0	D		0			0	0		0	0	0					0		WP	0			●			
Sevin	0			0				X		0			0			0	0	0								0				●		
Systox	0	0		0	WP		WP			0	0		0			0	0	0						0		0					●	
Thiodan	0			0			WP			0								0								0						●

This chart applies only to the use of two material combinations. When three or more materials are mixed or when a wettable powder and a liquid formulation are mixed, incompatibility may develop. *In all cases follow directions on the label.*

SPREADERS and STICKERS (SURFACTANTS) — Usually surfactants are incorporated into pesticide formulations by the manufacturer. Unless otherwise specified on the pesticide label, *do not* add surfactants.

MINIMUM NUMBER OF DAYS REQUIRED BETWEEN LAST PESTICIDE APPLICATION AND HARVEST

0 — No time restriction ☐ — Not recommended or not registered

CROPS PESTICIDES	Asparagus	Beans	Beets	Broccoli	Brussels Sprouts	Cabbage	Carrots	Cauliflower	Celery	Corn	Cucumber	Dill	Eggplant	Lettuce	Onions	Parsnips	Peas	Peppers	Potatoes	Radishes	Rutabagas	Spinach	Tomatoes
Ambush				7	3	3		3		1													
Basudin		7	14	5	14	7	10	5						10	10	10		5	14	10		10	1
Benlate		14									0												0
Birlane				40	40	40		40													40		
Botran		2																					
Bravo				7	7	7	1	7	7		1								7				1
Captan																							1
Coppers (fixed)		1	1	1	1	1	1	1	1		1		1					1	1			1	1
Cygon or Rogor or Dimethoate		7		4	21	4		4						7			3		7				
Dasanit				40	40	40		40													40		
Diazinon		7	14	5	14	7	10	5						10	10	10		5	14	10		10	1
Dibrom				4	4	4		4	4						4							4	
Difolatan															1				1				1
Dipel. Thuricide				0	0	0		0															
Di-Syston				42	30	42		30											90				
Dithane M-22														7	10·				1				
Dithane M-45															10·				1				
Dithane Z-78														10	7				1				
Du-ter																			14				
Dyrene									7:		1								1				
Furadan																			7		40		
Guthion																			7				
Karathane										30													
Kelthane											2				7								
Lannate				7	7	7		7		3				7			1••						
Lorsban				40	40	40	60	40	70		60				60				70		30		70
Malathion. Cythion	1	3		3	7	7		7	7		3	7		7	3		3						
Mantox														7	10				1				
Manzate-D														7	10·				1				
Manzate 200															10·				1				
Metasystox-R				21	24	24		24															
Methoxychlor																	7	1					1
Monitor				14	14	7		7						14					14				
Parathion				7	15	7	15	7	15					5•••	15		10•					7	
Phosdrin		1		2	3	2		3						3			1					3	
Pirimor										3							6	3	7				
Polyram																			1				
Rotenone				0	0	0		0						0									
Sevin	1									1	3						3	1	7				1
Systox				21	21	21		21									21						
Thiodan				7	7	7		7	14				2	14				2	1				2
Zineb														10	7				1				

• If pea vines are to be fed to livestock fresh or as hay or silage, do not treat within 15 days of harvest.

•• If lannate is used, do not feed pea vines to livestock.

••• 21 days for leaf lettuce.

· Not registered for use on green onions.

: If less than 7 days, wash and trim before packing.

Table 7: HERBICIDES FOR USE IN VEGETABLE CROPS

HERBICIDES	CROPS																													
	Asparagus	Beans, Snap	Beets, Red	Broccoli, Brussels Sprouts	Cabbage, Cauliflower	Carrots	Celery	Corn, Sweet	Cucumbers	Lettuce	Onions	Parsnips	Peas	Potatoes	Rutabagas	Squash, Pumkin	Tomatoes, Peppers	Barnyard Grass	Foxtail, Green	Wild Oats	Quack Grass	Black Nightshade	Blue Bur	Buckwheat, Tartary	Buckwheat, Wild	Catchfly, Night Flowering	Chickweed	Cocklebur	Corn Spurry	Cow Cockle
Afolan F/Lorox L	○					○	○					○		○				■	=					■			■			
Agricultural Weed Killer No. 1						○						○						■	■	■										
Alanap-3									○							○			■								■	■		
Amiben	○															○		■	■								■			
Amitol-T	○																													
Atrizine [1]								○										■	■	■					■					
Basfapon/Dalapon/Dowpon/Dowpon M	○													○				■	■	■	■									
Basagran		○						○					○									■					■	■	■	
Bladex								○											■			■			■					
Buctril M								○															■	■	■	■		■		■
Cipc										○	○																■			
Dual								○										■	■											
Dynap									○									■	■											
Eptam		○												○	○			■	■	■	=						■		■	
Eptam & Sencor or Lexone														○				■	■	■				■			■		■	
Eradicane 8-E								○										■	■	■	=						■		■	
Goal								○			○														■					
Gramoxone-Stale Seed bed		○	○	○	○	○			○		○		○	○	○															
Gramoxone-Precrop	○													○																
Hoe-Grass 284		○				○					○		○	○				■	■	■										
Kil-Mor								○														●	●	■	■	●		■	■	■
Laddok [1]								○														■					■	■	■	
MCPA-Sodium Salt,MCPA Amine	○												○										■					●		
Pardner, Torch								○																■	■					
Poast		○									○			○		○		■	■	■	●									
Prefar									○									■	■											
Primeextra [1]								○										■	■	●		●	■		■					
Princep Nine-T/Simadex/Simadex 80WP	○																	■		■					■	■	■			
Pyramin			○																			■		■			■			
Ro-Neet-7.2E			○															■	■	■		■								
Roundup-pre to crop								○						○																
Sencor/Lexone														○										■			■			
Sodium TCA			○															■	■											
Sutan +								○										■	■	●				■					■	
Treflan, Triflurex, Rival		○		○	○	○							○		○	○		■	■	■			■	■	■		■			■
Tropotox													○																	
Tropotox plus													○																	
2, 4-D	○							○														■						■		

CROPS

○ - Recommended on crop

[1] - These treatments will leave a residue in the following year. Reseed only to corn in the year following Atrazine application. Flax, peas, Fababea and barley are more tolerant to low levels of atrazin residue than other crops, excluding corn.

WEEDS																													
Flix Weed	Goosefoot, Dark-leaved	Groundsel, Common	Hemp Nettle	Henbit	Knotwood, Prostrate	Kochia	Lamb's-quarters	Lettuce, Prickly	Mustard, Tumble	Mustard, Wild	Mustard, Wormseed	Pigweed, Prostrate	Pigweed, Red Root	Pigweed, Russian	Pigweed, Tumble	Purslane	Ragweed Common	Russian-Thistle	Shepherds Purse	Smartweeds,Annual	Sow Thisle, Annual	Sow Thisle, Perennial	Stickweed	Sunflower, Wild	Thisle, Canada	Tomato, Wild	Volunteer Cereals	Voluteer Canola	HERBICIDES
		■	■		■	■	■			●	■	■	■			■	■		■	■	■		■					●	Afolan F/Lorox L
							■						■			■													Agricultural Weed Killer No. 1
							■						■			■	■												Alanap-3
							■						■			●	■			■			●						Amiben
						Controls most perennials and annuals																							Amitol-T
		●					■		■	■	■	●	■		●	■	■		●	■			●	●		●	●	●	Atrizine ¹
																													Basfapon/Dalapon/Dowpon/Dowpon M
		■					■		●	■	●		■			■	■	■	●	■			●		◢			●	Basagran
		●			■	●	■		●	■	■	◢	◢			■	■		■	■			●				●	●	Bladex
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		●		■			■			■		■	■		■	■				■			■				●	■	Eptam & Sencor or Lexone
			■	■								■	■		■	■										■			Eradicane 8-E
	■						■						■			■										●			Goal
						Controls annual weed seedlings and top growth of perennial weeds.																							Gramoxone-Stale Seed bed
						Controls annual weed seedlings and top growth of perennial weeds.																							Gramoxone-Precrop
																													Hoe-Grass 284
■					■	●	■		■	■	■	■	■	●			■	■	■	■	■	◢	■	●	◢	●		●	Kil-Mor
		■					■		●	■	●		■			■	■	■		■			●					●	Laddok ¹
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		■				■	■		●	■	●		●					■		■			■					●	Pardner, Torch
						Controls annual weed seedlings and perennial weeds																							Poast
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	■				■		■			■	■	■	■			■	■		■	■			■				●		Pyramin
				■			■						■			■											●		Ro-Neet-7.2E
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		●	■	●			■	■		■			●						■				■					■	Sencor/Lexone
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WEEDS - RESPONSE TO HERBICIDES

■ - Controlled. Check label for rate. Where two brand names are recommended, the weed may not be listed on both labels.

— - Suppression

● - Not labelled for control but adequate control can be expected.

◢ - Top growth control only.

◣ - Controlled by rates less than the minimum recommended for crops.

OPERATION AND CALIBRATION OF SPRAYERS

Field sprayers and its components are continually being upgraded or new products are introduced. For additional information on the subject consult the publication titled *Guide to Weed Control in Alberta, Part III, Herbicide Application Equipment, Agdex 744-5*

Components of Field Spraying Equipment

Four essential components of any chemical spraying equipment are the power source, pump, tank and nozzles. Others which must be considered are agitators, screens, filters, valves, pressure regulators, booms, hoses, gauges and handguns.

Power source

The power sprayer is normally driven by the PTO (power take-off) of the tractor or by an auxiliary engine, the power rating of which should be double the theoretical power required by the pump.

Pumps

A pump creates the pressure required for atomization and penetration of the spray. For pressure requirements of pumps, see under Recommended Pressures, page 36.

Choose a pump having the characteristics required for your job. Common pumps include the following:

roller pump (excessive wear can occur with wettable powders)

- piston pump
- diaphragm pump.
- The capacity of the pump should be determined by the highest rate of application the sprayer is expected to deliver, plus enough extra capacity for by-pass agitation.

Tanks

The size of the spray tank will depend on the intended rate of application and the mounting space available. It should be equipped with a large screened opening for easy filling and cleaning. Tanks may be constructed of steel, stainless steel, epoxy coated steel, fibreglass or aluminum. Fibreglass tanks are preferred because of their rust and corrosion resistance.

The rusting of steel tanks can be reduced by proper draining, cleaning and airing of the tank after use and by the use of rustproofing compounds. Either hydraulic (by-pass) or mechanical agitation must be provided. If hydraulic agitation is used in the spray tank, additional pump capacity is required. Mechanical agitation is preferred if wettable powders are to be used.

For proper mixing, it is important to know the volume capacity of your spray tank.

Nozzles

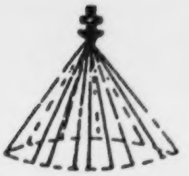
The size of droplet produced by various nozzles depends upon operating pressures and nozzle design. The droplet size decreases with an increase in pressure and with a decrease in nozzle tip opening.

The main types of nozzles used are:

1. Flat fan spray nozzle tips are the most common nozzle tip used for broadcast (overall) spraying. They produce a fan type pattern with less material applied along the edges of the spray pattern. By properly overlapping, a uniform pattern is produced across the spray boom. Nozzle spacing on the boom and height of the boom above the target are critical in obtaining a uniform application.

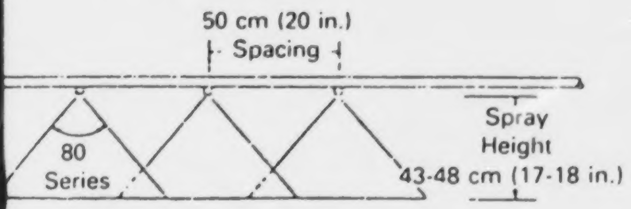
The greater the spray angle, the lower will be the boom height. Nozzle tips of 80° ot 110° are recommended to reduce susceptibility of spray solution to drift.

Low pressure tips ("LP" series) are designed to operate in the 100 kPa to 275 kPa range. The "LP" tips are useful at low pressures for pre-plant chemical applications.

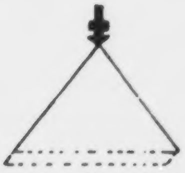


Spray pattern of flat spray nozzle tip

Overlapping of Spray Patterns with Flat Spray Nozzle Tips



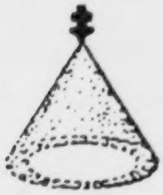
2. Even spray nozzle tips produce an even spray pattern across the entire fan width. These nozzles are used in band spraying of herbicides where there is no overlap from other nozzles.



Spray pattern of even spray nozzle tip

3. Flooding fan tips produce a coarser spray and a less uniform pattern than flat fan tips, but it reduces drift. They are used for applying either specified herbicides or mixtures of herbicides and liquid fertilizers. The best spray pattern is obtained when nozzles are spaced at 50 cm and operate with a 100 per cent overlap.

4. Hollow cone and solid cone spray tips are used primarily for applying insecticides and fungicides in row crop spraying. These nozzle tips produce small droplets at high pressure for thorough foliage penetration.



Spray pattern of solid cone nozzle tip

Whirl chamber nozzles produce a hollow cone pattern and are used mainly on herbicide incorporation kits. These produce relatively large droplets at lower pressures to minimize drift.

"Raindrop" nozzles also produce large droplets in a wide-angle cone pattern. These nozzles are mounted 90° to the horizontal, rather than straight down, as with other nozzle types. They are used primarily for soil-applied herbicides like Avadex BW and Treflan.

5. Rotary atomizers or controlled droplet applicators (CDA's) were introduced for low-volume applications of herbicides.

Research has shown that the range of droplets produced by rotary atomizers is narrower than the range produced by hydraulic nozzles. Also, droplet size can be varied by changing the speed of the disk and the rate of flow of the herbicide.

Good weed control can be obtained with low volumes of certain products when these applicators are properly used.

Disadvantages of commercially available units include poor penetration of the spray into the plant canopy and displacement of the swath by wind.

Nozzle sizes

Various sizes of flat and cone nozzle tips may be used to obtain the volume of water desired. Consult the following tables for nozzle output and application rates at various speeds. If additional information is required consult sprayer nozzle manufacturer's manual or the dealer.

Nozzle tip materials

Nozzle tips are made from a variety of materials. Choice of material depends upon the abrasiveness of the spray mixture. Wettable powders are more abrasive than emulsions. Brass tips are cheap but the metal is softer and the tips wear faster. In sequence of durability the following materials are used: plastic, nylon, brass, aluminum, porcelain, stainless steel, hardened stainless steel, Alumax, Kematal and ceramic.

As nozzle tips wear out, the rate of application increases. Tests have shown that some wettable powders wear nozzle tips sufficiently to increase the rate as much as 12% after spraying only 20 ha (50 ac). For this reason frequent calibration of equipment is necessary.

Screens

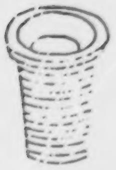
Screens prevent foreign material from entering the system, clogging the nozzles and wearing out the sprayer.

Suction strainers, line strainers and nozzles should all be equipped with 50 mesh screens when wettable powders are to be used.

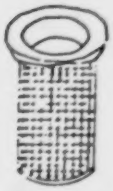
Screens finer than 50 mesh (100 mesh, for example) may prevent the unrestricted flow of some wettable powders.

Screens are generally used in fine nozzles, but slotted strainers can be used in those which have a larger opening and cone nozzles.

Clean screens and strainers are essential to the efficient operation of the spray system. They should be cleaned often and checked for breaks in the screen.



Slotted screen



Screen strainer

Volume required

The amount of water to be used varies with the pest, material and method of control.

Generally, for herbicides, use 30-50 gal/ac (300-500 L/ha) EXCEPT FOR CEREAL AND OILSEED CROPS USE 4-20 gal/ac (45-200 L/ha) and, for fungicides and insecticides, use 10-100 gal/ac (100-1000 L/ha). For certain purposes such as aphid and blight control in potatoes and root maggot control in cole crops, at least 100 gal/ac (1000 L/ha) of water should be used. The label may, however, specify other volumes for a specific pesticide. Read the label.

Recommended pressures

Herbicides are generally applied at low pressures (200 to 275 kPa or 30 to 40 psi) to keep drift to a minimum. Where higher pressures are recommended, these are specified within the recommendation.

Insecticides and fungicides are applied at pressures of 500 to 2100 kPa (75 to 300 psi) depending on the pest to be controlled, density of foliage and the type of boom. Thorough coverage of leaves is obtained with a drop pendant boom at pressures of 500 to 1100 kPa (75 to 150 psi). However, a simple flat boom may require pressures up to 1700 kPa (250 psi) to obtain the same coverage. Root maggot control requires a drench of a minimum of 100-200 gal/ac (1000 to 2000 L/ha) applied up to 200 kPa (30 psi).

Sprayer calibration

Sprayers must be calibrated before an application of a pesticide to determine the rate of spray solution being applied per hectare (acre). Knowing exactly the rate being applied prevents putting on too little or too much of the agricultural chemical. Before proceeding with calibration, the sprayer should be in good working order.

Step 1 - Fill the sprayer tank with water.

Step 2 - Set pressure and throttle at the desired position for spraying.

Step 3 - Spray with water over a convenient measure of distance in the field, 60m (200 ft) or more; the longer the distance, the more accurate the calibration.

Step 4 - Measure the amount of water required to refill the tank after spraying.

Step 5 - Calculate the rate at which the spray was applied by using the following formula:

Litres sprayed per hectare

$$= \frac{10{,}000 \text{ x litres used in test}}{\text{boom width (m) x Test legnth (m)}}$$

Litres sprayed per acre

$$= \frac{43560 \text{ x litres used in test}}{\text{boom width (ft) x test length (ft)}}$$

Step 6 - To determine the number of hectares (acres) you can treat with one tank of spray, divide the capacity of the tank by the number of litres per hectare (litres per acre) established in Step 5.

Step 7 - To calculate the amount of chemical required in a full tank of spray, multiply the number of hectares (acres) that one tank will treat by the recommended rate of chemical per hectare (acre).

Example (Metric)

A grower has a 450 L sprayer with a 7.2 m boom and wishes to spray Thiodan 4E at the recommended rate of 1.8 L/ha. After spraying a 100 m test strip 30 L of water are required to fill the tank. How many litres per hectare of water is being applied?

Follow Step 5:
Litres sprayed per hectare

$$= \frac{10{,}000 \times \text{litres used in test}}{\text{boom width (m)} \times \text{test length (m)}}$$

$$= \frac{10{,}000 \times 30\text{ L used in test}}{7.2\text{ m wide boom} \times 100\text{ m test length}}$$

$$= 417\text{ L/ha}$$

Follow Step 6:
Number of hectares one tank will spray

$$= \frac{\text{spray of spray tank (L)}}{\text{L sprayed per ha}}$$

$$= \frac{450\text{ L}}{417\text{ L/ha}}$$

$$= 1.08\text{ ha}$$

Follow Step 7:

Amount of Thiodan to add to tank = number of ha tank will cover x recommended rate chemical/ha

$$= 1.08\text{ ha} \times 1.8\text{ L/ha}$$

$$= 1.9\text{ L}$$

Add 1.9 L of Thiodan 4E to one spray tank.

Example (Litres/acre)

A grower has a 450 L sprayer with a 24 foot boom and wishes to spray Thiodan 4E at the recommended rate of 0.73 L/ac. A 300 foot test strip is sprayed and 30 litres of water are required to refill the tank. How many litres per acre of water is being applied?

Follow Step 5:
Litres sprayed per acre

$$= \frac{43500 \times 30\text{ L used in test}}{24\text{ ft wide boom} \times 300\text{ ft test length}}$$

Litres sprayed per acre

$$= 181\text{ L/acre}$$

How many acres will one tank cover?
Follow Step 6:
Number of acres one tank will spray

$$= \frac{\text{size of spray tank (litres)}}{\text{gallons sprayed per acre}}$$

$$= \frac{450\text{ L tank}}{180\text{ L per acre}}$$

$$= 2.50\text{ acres.}$$

One tank will spray 2.50 acres.

How much Thiodan 4E should be added to a tank?

Follow Step 7:

Amount of Thiodan to add to tank = number of acres one tank covers x rate of chemical per acre recommended

$$= 2.50\text{ acres} \times 0.73\text{ L/acre}$$

$$= 1.82\text{ litres}$$

Add 1.82 L of Thiodan 4E to 1 sprayer tank.

Adjusting sprayer output

The output of the sprayer can be adjusted in three ways:
1. Adjustment in pressure--not recommended for increasing spray rate. Follow label directions for correct spray pressure. 2. Varying the speed of application--volume sprayed increases as driving speed decreases; e.g., if at 10 km/h sprayer output is 112 L/ha, at 5 km/h output will be 224 L/ha.
3. Changing nozzle tips--select the nozzle tip that provides the desired spray volume at a convenient speed.

Band application

In cultivated crops, spraying narrow bands of herbicide over the rows will take less material, cutting the cost per hectare (acre) for the chemical. Where chemical costs are high, band spraying may be justified. However, with band spraying, timely cultivation of weeds in the unsprayed area between rows is necessary. In seasons when the soil is too wet to cultivate, overall spraying has the advantage of controlling weeds between the rows.

When band spraying, be very careful to maintain the proper rate of application on the area sprayed. If you lower the spray boom to narrow the area covered by a given nozzle, remember that each nozzle is still delivering the same amount of spray mixture as it did on the wider area.

To calculate the amount of pesticide required, use the following formula:

width of band (in. or cm) x recommended rate per acre (ha)
row width (in. or cm)

Mixing chemicals

Chemicals should be added to the spray tank when it is partially filled with water. If combinations of spray materials are used, always add wettable powders to the tank first and then add emulsifiable concentrates or crop oils. Once the chemicals are added, the agitator should be kept running to keep the spray properly mixed. Without agitation, wettable powders may settle out.

For best results, wettable powders should be premixed before being added to the spray tank. Make a slurry of wettable powder and water and then pour it into the spray tank.

Always follow manufacturers' directions when mixing chemicals.

Sprayer cleaning

Immediately after use, the sprayer should be flushed out with soapy water and then rinsed with clean water.

Separate equipment is recommended for applying 2,4-D, MCPA or similar hormone type herbicides, expecially on cole crops and other sensitive crops. If this is not possible, use separate sprayer hoses when using these chemicals as they cannot be properly washed out of the hose lines. To clean equipment after applying 2,4-D, MCPA amine or salt formulations, follow these steps:

1. After draining sprayer thoroughly, fill with clean water and circulate through pump, lines, etc.
2. Drain the sprayer.
3. Remove nozzles and screens and wash separately.
4. Fill with clean water containing 1 part of household ammonia per 100 parts of water.
5. Circulate this solution through the entire sprayer system.
6. Wash down the inside of the tank with a mop or scrub brush.
7. Allow to stand overnight.
8. Recirculate cleaning solution for 5 to 10 minutes.
9. Drain entire sprayer system.
10. Rinse with clean water.

After the use of 2,4-D ester and Glean, different cleaning procedures are required. Please consult your district agriculturist.

Plugged tips should be cleaned with a toothbrush or other soft material. Never use your mouth to blow a tip clean. The tips should be removed and stored so they will not be damaged.

Caution when using wettable powder formulations

Constant mechanical agitation in the spray tank is necessary to keep wettable powders in suspension for uniform spraying. Line and nozzle strainers should be at least 50 mesh to prevent clogging. DO NOT add a wettable powder directly into the spray tank.

First make a slurry by stirring the required amount of powder with water in a pail and add to the spray tank when filling with water. If addition an emulsifiable oil is recommended, follow the above procedure and add the emulsifiable oil last while agitating.

Spray residue tolerances

The federal health protection branch issues regulations governing the amount of chemical residue on vegetables or other food products.

These regulations are enforced by law, and growers are warned that food products carrying chemical residues in excess of the allowable tolerances may be seized. The recommendations in this publication give dosages and suggest practices that will result not result in excessive residue in the crop. (See Pesticide Regulations).

Minimum number of days between last application and harvest

Before using a pesticide, check the label on the container to determine the number of days that must be left between application and harvest. Pesticides applied closer to harvest than the label recommends are likely to result in excessive residue in or on the crop. See "minimum days before harvest", in parentheses at the end of each crop recommendation.

Herbicide residues in soil

Plan your crop rotation. A number of herbicides may remain in the soil and may affect crops in the year following use. Others may be retained and affect crops planted later in the same year. Persistence in soil will vary according to application rate, soil type, water and environment. The values given in the following table are meant to be used only as a quick guide. Always check the label for complete information.

Trade Name	Common Name	Longevity in Soil
Aatrex	atrazine	2 years +
Afolan	linuron	1 year +
Amitrol-T	amitrole	2-4 weeks
Atra-Mix Concentrate	atrazine + oil conc.	2 years +
Avadex BW	triallate	1 season
2,4-D	2,4-D	10 weeks
Glean	chlorsulfuron	4-5 years
Lexone	metribuzin	1 year
Lorox	linuron	1 year +
Primextra	metloachlor - atrazine	2 years
Pyramin	pyrazon	1 year
Sencor	metribuzin	1 year
Tordon 202C	picloram + 2,4-D	3-5 years
Treflan	trifluralin	1 year +

Abbreviations

The following abbreviations are commonly used on pesticide containers and in the recommendations used in this guide:

a.i. = active ingredient
EC = emulsible concentrate
WP = wettable powder
SC = soluble concentrate
SP = soluble powder
SL = soluble liquid
F = flowable
D = dust
G = granular
L = liquid
OF = dry flowable

SECTION 3
SOIL MANAGEMENT AND FERTILITY

INTRODUCTION

Important aspects of soil that should be considered are soil texture, drainage, soil reaction, soil salinity, organic matter, and fertility.

SOIL TEXTURE

Texture describes the relative proportion of clay, silt and sand that make up a soil. Clay particles are very small, silt particles medium size, and sand particles the largest. All soils differ in proportions of sand, silt and clay.

The soil test identifies five texture classes for mineral soils and is shown on the soil test report:

1) Very coarse (sand)
2) Coarse (loamy sand, sandy loam)
3) Medium (loam, clay loam, sandy clay loam and sandy clay)
4) Fine (silt loam, silty clay loam)
5) Very fine (clay, heavy clay).

A sixth group, organic soils, have no 'texture' as such since they contain very little or no mineral particles. Organic soils are not used for commercial vegetable production in Alberta, but they can be productive soils and interested producers are urged to contact Alberta Agriculture for more information.

Generally, deep, well drained, coarse textured soils such as loamy sands, sandy loams and loams are the best soils for vegetable production. Where possible sands and clay soils should not be used for vegetable production.

The advantages of coarse textured soils, that is those that have a relatively high proportion of sand, are:

1) generally warmer soils
2) usually well drained and provide good aeration around roots; have the least problem with salt build up
3) 'looser' and allow for smooth even development of root crops
4) generally easier to cultivate, do not create compaction or crusting problems, and present fewer harvest problems for root vegetables.

The disadvantages of coarse textured soils include:

1) drying out on the surface quite readily which may contribute to poor emergence
2) low water holding capacity
3) very coarse soils are subject to erosion
4) tendency to have low nutrient levels.

The advantages and disadvantages of the soils such as clay loams and clays are the converse of those for light soils and are therefore better suited to above-ground crops. The advantages of coarse textured soils tend to outweigh the advantages for fine soils and therefore are preferred, in general, for vegetable production.

DRAINAGE

Drainage, that is, the ability of excess moisture to filter through the soil and drain away, is affected by the texture and structure of surface soil and subsoil, and by organic matter and slope.

For obvious practical reasons soils used for vegetable production should be well drained. Soils must be free of excess moisture which can cause delays in field operations and promote disease.

Growers wishing information on correct drainage problems should contact their irrigation specialist.

SOIL REACTION (pH)

Soil reaction or pH, which is given in a soil test report, is a measure of the acidity or alkalinity ("sweetness") of a soil. The terms alkaline and alkali should not be confused. Alkali is an old term used to describe soils which are high in sodium salts.

Soils with pH's of 6.5 to 7.5 are considered neutral and most vegetables grow well in this range. Soils of PH 6.0 or less are considered to be acid. There are some acid soils in central and west central Alberta and Peace River area that would benefit from liming. Generally, there are very few acid soils in southern Alberta, and liming is not required. Soils whose pH range is from 7.8 to 8.5 or higher are said to be alkaline. These soils can have associated salt problems and require special attention.

SOIL SALINITY

Soil salinity, often referred to as alkali, may be a problem in many parts of Alberta. Saline soils are often formed in areas where there is an excess of water which rises to the surface and evaporates leaving salts accumulated on the soil surface. The use of irrigation water that has a high salt content may cause soil salinity to develop. Saline soils crust easily, and are difficult to till if they are too wet or dry. Severe soil salinity will cause bare white spots in a field, but moderate levels of soil salinity cause poor growth of salt sensitive crops. Differences in tolerance to salinity exist between various crops and in some cases varieties of the same crop. Soil salinity is measured by electrical conductivity and is reported as such in the soil test. The soil test also reports the amounts of sulphates and sodium. The levels of these are determined because they commonly cause salinity problems. Some crops, such as beets, are sensitive in the seedling stage and later become tolerant.

Crops growing in a saline area show reduced growth and may have leaves which are darker colored than normal. Soil salinity damage to crops will cause a burning on the edge of the leaves and the plants may wilt when the soil is still moist.

It is preferable to grow high value vegetable crops on non-saline soils. If saline soils are used, only those crops which are tolerant to the level of salinity present in the soil should be grown. It is possible to reclaim saline soils by subsurface drainage, but this is costly and the vegetable grower should first consult an irrigation specialist.

Fertilizer materials are salts and, if they accumulate in the soil in excess amounts, can interfere with germination and growth just as natural soil salts do. It is for this reason that relatively high amounts of soluble granular fertilizers (nitrogenous) should not be placed with or near seeds.

SOIL ORGANIC MATTER

Organic matter is a general term applied to plant and animal tissue in various stages of decomposition. Crude plant material such as roots, leaves, vines, stems and straw do not become organic matter until it starts to decompose.

As organic matter decomposes, it performs many important functions in the soil and contributes to plant growth. Functions of organic matter include:

1) serves as a source food for growth and reproduction of soil microorganisms
2) source of both macro and micro nutrients for growing plants
3) release of chemicals during decomposition. Acids are formed which in turn release plant nutrients from soil minerals
4) improves soil structure, aeration, water penetration and water holding capacity of the soil through both physical and chemical action.

When vegetables are grown in combination with grain and hay crops and when manure is applied to vegetable fields, good soil structure and levels of organic matter can be maintained. Grain and hay crops help alleviate compaction and add organic matter to the soil if the straw and stubble are plowed down.

When vegetables are the only crops grown, soil compaction can occur because organic matter is broken down more rapidly and very little organic matter is replaced. Between the rows the land is similar to fallow thus the decomposition of organic matter is more rapid. It is important to maintain the organic matter content of the soil.

Organic matter levels are given in a soil test report.

MAINTAINING SOIL ORGANIC MATTER

A market garden or commercial vegetable operation should consider a program of cropping that will maintain or replenish soil organic matter. Such a program is more critical on Brown and Dark Brown soils than on Black soils.

There are three main methods by which

Salt tolerance of crops from the late seedling stage until maturity

Sensitive (0-4 millisiemens/cm mmhos/cm)	Moderately Sensitive 4-8 millisiemens/cm or mmhos/cm)	Moderately Tolerant (8-15 millisiemens/cm mmhos/cm)
Bean	Broccoli	Beets
Carrots	Brussels sprouts	Spinach
Celery	Cabbage	Asparagus
Eggplant	Cauliflower	
Onion	Cucumber	
Peas	Lettuce	
	Pepper	
	Potatoes	
	Radish	
	Tomatoes	

organic matter can be maintained or replenished in the soil. They involve additions of organic residues in the form of animal manures, crop residues and green manures.

When acreage is limited and cropping is very intensive, the application of manure may be most practical (see section on use of manures). Plowing down mature crop residues, such as grain stubble, is more feasible where vegetables are only part of a large farming operation.

Green manures can be left to overwinter as a cover crop. The cover crop will help prevent soil erosion and hold snow on the field. Crops which can be used for cover crops include spring wheat and oats seeded at about 45 kg per acre (110 kg per hectare). A mixture of 28 kg per acre (70 kg per hectare) of peas and 45 kg per acre (110 kg per hectare) of oats, or straight oats, are good green manure crops that can be planted and plowed down the same year.

When green manure crops are sown they should be fertilized with about 45 to 90 kg per acre (110 to 225 kg per hectare) of fertilizer such as 16-20-0. Some of the nitrogen and most of the phosphorus will be available for the following vegetable crop.

If a green manure crop is left overwinter, broadcast the fertilizer planned for vegetable crops after plowing down the manure crop but prior to shallow cultivation. Additional nitrogen fertilizer 40 to 65 kg per acre (110 to 160 kg per hectare) of 34-0-0 may be required to replace that used in the breakdown of the green manure crop.

SOIL TESTING AND SAMPLING GUIDE

Soil testing has become a very important tool for assessing soil fertility and arriving at proper fertilizer recommendations. It is also a valuable management aid for studying soil changes resulting from cropping practices and for solving specific cropping problems.

The biggest problem in the effective use of soil testing is proper and representative sampling. The following information is offered to answer special questions concerning soil sampling. Further information and guidance can be obtained by contacting your district agriculturist, fertilizer dealer or one of many soil testing laboratories in Alberta. There are private laboratories in Lethbridge, Brooks, Crossfield and Edmonton plus the government laboratory in Edmonton (Soils and Animal Nutrition Laboratory, 6909 - 116 Street, Edmonton T6H 4P2). Soil sampling kits are available from district agriculturist offices for samples to be analyzed by the government laboratory in Edmonton.

When to sample: Cultivated fields for spring seeding should be sampled after October 1. These fields can also be sampled in the spring but time is limited. Problem soil areas may be sampled any time. Frozen and water-logged soils should not be sampled because of the difficulty of obtaining a representative sample.

Size up your fields: Each field (with the same crop and management) must be sampled separately. Fields larger than 25 to 30 hectares (60 to 75 acres) should be divided into two or more for sampling depending on soil and crop variability.

Size up each field and observe variations in yield and crop growth, texture, color, slope, degree of erosion, drainage, and past treatment. Sample separately sizable areas where growth is significantly different from the rest of the field. Avoid unusual areas such as dead or back furrows, old straw, hay or manure piles, waterways, saline spots, eroded knolls, and old fence rows. Select 15 to 20 sampling sites representative of the portion of the field to be tested. Mix these samples together to obtain a representative sample to send to the laboratory of your choice.

Sampling tools and methods: Representative soil samples can best be obtained by using core sampling tools. These are generally available on request from district extension offices and fertilizer dealers. A spade may also be used to take surface samples 0-15 cm (0-6 in.). Dig a wedge-shaped hole 18 cm (7 in.) deep and remove a 2 cm (1 in.) slice of soil from the side of the hole. With a sharp instrument cut away each side of the slice leaving a uniform core 2 x 2 x 15 cm (1 x 1 x 6 in.), which is collected. The use of a proper sampling tool is essential for sampling to depths below 15 cm (6 in.). Information on a depth sampler may be obtained from any soil testing laboratory.

Field sampling: Take a soil core from 0-15 cm (0-6 in.) at each of the 15 to 20 sampling sites. For improved nitrogen evaluation particularly on irrigated soils or where problem soils are encountered, separate samples should be taken from 0-15, 15-30 and 30-60 cm (0-6, 6-12 and 12-24 in.) depths at 15 to 20 sites. Place cores in clean pails or bags then mix cores taken from same depths, crushing lumps in the process. Keep samples taken from different depths separate from one another.

Drying soil samples: Remove a half kilogram (one pound) or more of each soil sample and air dry to stop nitrate build-up. To air dry, spread a thin layer of soil on a clean piece of paper in a clean room at room temperature. **DO NOT DRY WITH ARTIFICIAL HEAT.**

Packing and mailing: Place the plastic bag inside the sample box, then fill the box completely. Tie the bag and box securely and label each box with your name, address, postal code, sample number, and measurement of depth of the sample.

Repeat these steps for each uniform field to be sampled. When two or more soil samples are to be submitted, place the samples in a shipping container.

Filling out the information sheet: Provide complete information for each soil sample on the sheet supplied for samples to be sent to the laboratory of your choice. Where unusual problems exist, these should be noted in detail. Keep a complete field plan of the area represented by each sample for your own records.

Submitting soil samples: The government soil testing laboratory fee is $15 for surface samples. For this fee, analyses are provided on one surface sample, 0-15 cm (0-6 in.), plus two subsurface samples, 15-30 cm and 30-60 cm (6-12 in. and 12-24 in.) if they are submitted at the same time. Fees must be forwarded at the same time as the sample. Please make cheques or money orders payable to the PROVINCIAL TREASURER if sending to the government laboratory. Do not send cash through the mail. Place the fees and the information sheet in the self-addressed envelope supplied for this purpose and mail at the same time as the samples.

Private soil testing laboratories should be consulted when submitting samples to them.

SOIL NUTRIENTS MEASURED IN A SOIL TEST

The plant nutrients that are likely to be lacking in Alberta soils are nitrogen, phosphorus, and to a lesser extent sulphur and potassium. Few soils are so deficient in one or more of these nutrients that obvious deficiency symptoms develop on the plants. Deficiencies of micronutrients have rarely been encountered or documented.

Fertilizer requirements will vary from field to field and from year to year. Therefore, soil tests should be used as a tool to determine the kind and rate of fertilizer to apply. The general recommendation given for each crop should only be used as a guide when a soil test is not available. The following is a description of the various soil tests and their use.

Nitrogen

The nitrogen test measures available nitrogen (nitrate) in the soil at the time of sampling. Therefore, to assess the nitrogen status of the soil for determining nitrogen fertilizer requirements, soil samples should be taken in late fall or early spring. Nitrate nitrogen moves readily with soil moisture. Therefore, on irrigated soils in particular, soil samples should be taken to a depth of 0.5 metre (2 ft) to accurately assess the level of available nitrogen. (See the soil sampling guide in the soil testing kits.)

In addition to the available nitrogen in the soil at planting, available nitrogen is released by the soil during the growing season. Soils that have recently been manured or broken from a legume or grass-legume mixture will release larger amounts of nitrogen during the growing season. This information must be supplied with the soil samples so that nitrogen fertilizer recommendations can be adjusted accordingly.

Phosphorus

The level of available phosphorus in a particular field does not change dramatically from year to year unless very high rates of phosphate fertilizer or manure are applied. A soil test for phosphorus can be used as a guide to phosphate fertilizer requirements for 2 to 3 years. Periodic evaluation of the soil phosphorus level will provide a useful guide to changes in this nutrient over a period of time.

Potassium

Soils in southern Alberta are not generally deficient in potassium, but some soil types in west central Alberta and northeastern Alberta are often moderately low in available potassium. Most soils in southern Alberta are high in available potassium, but some sandy soils may be deficient for potatoes which have a very high potassium requirement. A soil test should be used to identify a need for the use of potassium fertilizers in a cropping program. Periodic soil tests will provide an assessment of changes in the potassium level in the soil over time.

Sulphur

Some soils in central, northern and western Alberta are deficient in sulphur. The test for sulphur is done in areas where it is known to be deficient and will be done in other areas upon request.

THE ROLE OF SOME PLANT NUTRIENTS IN VEGETABLE PRODUCTION

There are basically two types of plant growth. The first is vegetative, which results mainly in an increase in size of plant parts and involves cell growth. Nitrogen plays a major role in this type of growth. The second type of growth, known as a differentiated type, is concerned with the reproduction of the plant, which involves the formation of flowers, fruit and seeds. Phosphorus plays a leading role in this type of growth.

Plants require 16 essential elements to function properly. Thirteen of these elements must be taken up from the soil. Some elements are taken up by plants in relatively large quantities (macronutrients). An excess supply of some elements (boron) can be toxic to plants. Specific roles of plant nutrients are very complex and not well understood, however, some of their basic functions and effects on plant growth may be helpful when observing crops.

Nitrogen

The soil should contain sufficient nitrogen to provide for adequate vegetative growth in the plant. A deficiency of nitrogen can result in plants with small leaves and stems, pale yellowish-green color, and reduced protein. The lower leaves may be affected first, but other leaves follow, yellowing progresses to drying up and shedding. Excess nitrogen results in succulent, weak stems and delayed maturity.

Phosphorus

This nutrient stimulates root formation and early plant growth, promotes seed and fruit formation and hastens maturity. A deficiency of phosphorus may result in smaller than normal plants or stunted growth. Purplish discoloration of mature leaves may occur on some crops. Corn and tomatoes may show a purplish color owing to a phosphorus deficiency caused by cool weather early in the spring. These normally disappear as temperature increases.

Potassium

Unlike nitrogen and phosphorus, which make up part of the plant structure, potassium plays a regulatory role. But, like the other two, it also is required in relatively large amounts. Potassium has been reported to affect the appearance and quality of fruits and vegetables. Scorching or firing along the leaf margins of older leaves is the most common symptom of potassium deficiency. A deficiency of potassium may result in a distracting bluish-green color in some vegetables and in slender stems in crops such as celery. Adequate potassium was shown to result in uniform ripening in tomatoes, and deficiency may cause a dark color in potato chips. Excess potassium may result in lowered quality (reduced dry matter content of potatoes).

Sulphur

This nutrient has a number of important functions in plant nutrition including the building of amino acids, formation of chlorophyll and the production of enzymes. Sulphur deficiency symptoms are very similar to nitrogen deficiency where leaves become uniformly yellow and plants tend to be weak and stunted. These symptoms generally appear first on the upper leaves and then progress to the whole plant. Nitrogen usually commences with the older lower leaves.

Calcium

Calcium's role in plant growth is very complex, but its primary function is in the formation of cell walls. A deficiency shows mainly as yellow leaves on the upper plant parts. Tomatoes become misshapen and black dead areas develop near the blossom end (blossom-end rot). Celery develops brown to black decaying areas in its heart leaves (blackheart). Carrot roots with a deficiency are rough and develop pits (cavity spot).

Foliar sprays will correct calcium deficiency in tomatoes and celery, but soil applications are more effective in carrots. The sprays should be repeated every 7 to 10 days, beginning when celery is about 20 cm (10 in.) tall and when tomatoes begin to form their first fruit.

MICRONUTRIENTS OR TRACE ELEMENTS

Soil tests for micronutrients are not made on a routine basis as there are few cases of confirmed micronutrient deficiency. Micronutrients should not be applied unless a specific deficiency has been identified from plant symptoms. Use of micronutrients, where they are not required, is not only a waste of money but could easily cause an excess, which may be toxic.

Trace elements or micronutrients should not be combined with insecticide or fungicide sprays unless the manufacturer's directions indicate that this may be done or experience has shown they are compatible.

Trace or microelements should be applied only on competent advice or where experience has proven their application to be necessary. Soil or foliar applications can be made. Soil applications are generally made at soil preparation time and foliar applications are applied during the growing season. A sticker-spreader should be included in trace element sprays.

Boron

This nutrient is required by plants in relatively small amounts, but its deficiency can cause a breakdown of internal tissues in some root crops (e.g., black rot or water core in rutabagas and canker in table beets). If a deficiency is diagnosed, boron supplementation with Borax, Solubor or Borospray must be carried out very accurately because excess boron is toxic to plants.

Manganese

The general symptoms of manganese deficiency are interveinal chlorosis (yellowing) of leaves which begins in the younger foliage. A russeting, curling and dwarfing of the foliage occurs in beets. Other crops susceptible to manganese deficiency are beans, carrots, onions, celery, and tomatoes. Spray applications have proven more effective than soil applications. Apply manganese as directed by a soils or crop specialist.

Iron

Iron deficiency is characterized by chlorosis (yellowing) of the younger leaves. Tissue between the veins turns yellow while the veins themselves remain green. Iron is usually abundant in the soil, but its uptake by plants can be slowed down when there is excess of lime in the soil, the pH is high or when soil is cool and wet. Iron sprays or drenches may be applied when iron deficiency is confirmed.

Other trace elements

Other trace elements may be deficient on occasion. These include copper, magnesium, molybdenum and zinc. Consult an agronomist, soils specialist or a soil and feed testing laboratory if micronutrient deficiencies are suspected.

TYPES OF FERTILIZER MATERIALS

Manure

Animal wastes can add both organic matter and nutrients to the soil.

When manure is readily available it can be used as a good source of nitrogen, phosphorus and potassium. When manure has to be hauled long distances, its benefits are outweighed by trucking costs since about 8 to 10 tonnes per acre (20 to 25 tonnes per hectare) are usually applied.

The amount of nutrients in manure varies a great deal. It will depend on several factors: the type of animal, the type of feed, the feeding method, age of the manure, and method of storage. Fresh manure is usually very high in nitrogen, but nitrogen can volatilize into the air or be leached out by rain. The levels of nitrogen in old manure may be very low.

As a rough guide, a grower could expect that a 4 to 6 tonne per acre (10 to 15 tonne per hectare) application of pig, beef or dairy manure would add about 8 to 28 kg per acre (20 to 70 kg per hectare) of nitrogen, phosphorus and potassium.

When using manures in combination with commercial fertilizers, reduce the amounts of fertilizer nutrients by taking into account the amount of nutrients added by the manure. It is very important to monitor the nutrient content of soil by soil testing.

Manure should not be applied in the same year that potatoes and rutabagas are to be grown. Potatoes may become scabby and rutabagas uneven and cracked.

Since fresh manure can be a source of weed seeds, caution is advised when buying and spreading manure. Most weed seeds are still able to grow after passing through an animal. Some manure, especially fresh manure, can carry large amounts of viable weed seeds that can infest clean land. Manure that is known to have weed seeds in it is usually suitable for spreading after it has been piled for a period of one or two years. The viability of most weed seeds should be destroyed in this period. On occasion manure, especially from feed lots, can contain a high level of salts, which if added to a soil already slightly saline could further add to the soil salinity.

Manure should be applied in the fall and immediately worked into the soil. This practice allows for adequate mixing and breakdown of manure before spring seeding and also prevents loss of nitrogen to the air.

Commercial fertilizers

Pricing fertilizers

The Fertilizer Act requires that fertilizers be labelled according to their guaranteed analysis in terms of percent by weight of nitrogen (N), phosphate (P_2O_5), and potash (K_2O). For example, 45 kg (100 lb) of 11-48-0 contains 5 kg (11 lb) of nitrogen (N), 22 kg (48 lb) of phosphate (P_2O_5), and 0 kg (0 lb) of potash (K_2O). Fertilizer should be purchased on the basis of the price per kilogram (lb) of nutrient not price per tonne (ton) of material.

Nitrogen fertilizer placement

Nitrogen moves readily in moist soil and therefore need not be applied near the seed to be utilized effectively. However, surface application or shallow incorporation can result in reduced uptake if the seedbed remains dry during the early growing season. Nitrogen applied in a band at a depth of 11-15 cm (4-6 in.), (i.e. an anhydrous ammonia application), or drilled in with the seed may be more effective when the surface soil remains dry for an extended period during the early growing season.

Too much nitrogen drilled with the seed can reduce germination and seedling emergence.

Time of Application. Nitrogen fertilizers can be applied in either late fall or spring with similar results. Nitrogen applied in the fall has a greater opportunity to move deeper into the root zone and therefore may be more effective than spring broadcast nitrogen under dry conditions. Excessively wet conditions that sometimes occur on fine textured and poorly drained soils in central and northern Alberta can cause significant losses of all applied nitrogen because of denitrification (loss of gaseous nitrogen under saturated conditions). Therefore, fall application is not recommended on poorly drained areas where the soil remains saturated or flooded for an extended period in the spring. It is preferable to delay fall application of nitrogen until the soil temperature has declined to 10°C or less.

Nitrogen fertilizer sources.

1) Ammonium nitrate (34-0-0):
   - contains nitrogen in both the ammonium and nitrate form
   - less subject to volatilization than urea when surface applied without incorporation
   - more subject to leaching losses on sandy soils
   - used with ammonium phosphate to make the common fertilizer grades 23-23-0 and 26-13-0.
2) Ammonium sulphate (21-0-0-24S):
   - 24% sulphur
   - used for direct application as both a nitrogen and sulphur source
   - used with ammonium phosphate to make 16-20-0
   - more acidifying than other nitrogen fertilizers and therefore should not be used continuously on acid soils.
3) Urea (46-0-0):
   - highest analysis dry nitrogen fertilizer
   - used for direct application or combined with phosphate to make 27-27-0
   - more subject to 'evaporation' when not incorporated into the soil.

   Significant losses can occur when urea is applied under warm dry conditions to sandy soils, and on alkaline soils (pH 7.5 or higher).
4) Anhydrous ammonia (82-0-0):
   - highest analysis nitrogen fertilizer
   - suitable for fall or spring application for annual crops
   - a narrow shank applicator with 40 cm (16 in.) spacing is commonly used to inject ammonia at a depth of 10-15 cm (4-6 in.). The soil must be worked sufficiently close behind the application shank to prevent escape of the ammonia gas.

CAUTION: Anhydrous ammonia is a pressurized gas. Everyone involved in the handling and use of ammonia should be aware of the need for caution. For further information see your fertilizer dealer or the following publication:

Agriculture Ammonia Safety
The Fertilizer Institute
1015 - 18 Street NW
WASHINGTON, DC 20036

5) Urea
   - ammonium sulphate (34-0-0-11S):
   - contains 11% sulphur
   - supplies adequate sulphur when used as the nitrogen source on sulphur deficient soils.
6) Urea
   - Ammonium nitrate solutions (28-0-0 and 32-0-0):
   - losses from volatilization and immobilization may occur if sprayed on heavy trash cover
   - solutions lend themselves to uniform application and ease of handling.
7) Urea - Ammonium sulphate solution (20-0-05S):
   - contains 5% sulphur and will supply adequate sulphur when used as the nitrogen source on sulphur deficient soils.
   - comments under No. 6 also apply to 20-0-05S.

Phosphate fertilizer

Phosphate fertilizer does not move readily in soil so it must be placed near the seedling roots to be most effective. Phosphate fertilizer should be drilled with or near the seed for annual crops. On perennial crops like asparagus, a greater response may occur in the years following application than in the year of application. On soil very deficient in phosphorus, phosphate fertilizer should be applied and incorporated prior to seeding perennial crops.

Phosphate fertilizer sources

1) Monoammonium phosphate (11-48-0, 11-51-0, 11-54-0 and 11-55-0):
   - the most common phosphate fertilizer available
   - used for drill-in or hand application on annual crops, or may be

broadcast
- blended with nitrogen fertilizers to give various nitrogen-phosphate fertilizers such as 16-20-0, 23-23-0, 27-27-0 and 26-13-0.

2) Diammonium phosphate (18-46-0):
- used to a limited extent as a drill-in application in place of 11-48-0 or 11-55-0 where more nitrogen is required.
- there is some evidence indicating that diammonium phosphate is slightly less efficient than monoammonium phosphate on calcarious soils (soils containing free lime).

Potassium Fertilizer

Potassium will move in the soil more readily than phosphorus, but for annual crops, potassium fertilizers are more efficient when drilled with or near the seed. Broadcast applications can be used at about twice the rate used for drill-in application. For small-seed crops, the maximum safe rate with the seed is 17 kg/ha (15 lb/ac). Broadcast applications can be made in either fall or spring.

Potassium fertilizer sources

Muriate of potash (0-0-60 or 0-0-62):
- most commonly available potassium fertilizer
- used directly as a broadcast application or mixed with phosphate and nitrogen fertilizers to make fertilizer grades such as 10-30-10, 8-24-24, 13-13-13, etc. Note--the cost of potash in some of the complete fertilizers tends to be considerably higher than in 0-0-60 or 0-0-62. Therefore, prices should be compared on the basis of cost per kilogram (pound) of nutrient.

Sulphur fertilizer

Sulphur in the sulphate form moves readily in moist soils. Therefore soluble sulphate fertilizers provide a readily available sulphur source either as broadcast or drill-in applications. Elemental sulphur and gypsum can also be used as sulphur fertilizers but are not immediately available to plants.

Sulphur fertilizer sources.

1) Ammonium sulphate (21-0-0-24S):
- contains 24% sulphate sulphur
- used directly as both a nitrogen and sulphur source or combined with ammonium phosphate to produce 16-20-0-14S or with urea to produce 34-0-0-11S.

2) Urea-ammonium sulphate (34-0-0-11S):
- contains 11% sulphur
- not as acidifying as ammonium sulphate and therefore preferable for use on acidic soils that are sulphur deficient.

3) Ammonium phosphate-sulphate (16-20-0-14S):
- made from monoammonium phosphate and ammonium sulphate
- common source of nitrogen, phosphorus, and sulphur for broadcast and drill-in application.

4) Urea-ammonium sulphate solution (20-0-0-5S):
- see comments for 34-0-0-11S and 28-0-0 and 23-0-0 solutions.

5) Elemental sulphur (Agri Sul--90% S):
- a granular elemental sulphur fertilizer that can be used directly as a broadcast application or blend with other fertilizers except ammonium nitrate
- elemental sulphur must be converted to sulphate sulphur before it is available to plants. Therefore, it will not be available as quickly as a soluble sulphate fertilizer such as ammonium sulphate, but will have a longer residual effect.

6) Gypsum ($CaSO_4 2H_2O$):
- contains 18% sulphur in the sulphate form, but is not as soluble as ammonium sulphate
- supplies both calcium and sulphur.

STARTER SOLUTIONS

High analysis, water-soluble fertilizers which contain over 50% of at least two of the nutrients--nitrogen (N), phosphate (P_2O_5), and potash (K_2O)--are referred to as starter solution chemicals. Starter solutions are used at planting time to stimulate the growth of young transplants by increasing the amounts of readily available nutrients. Soil nutrients are not readily available to plants in cool weather.

Vegetable crops will benefit if starter solutions are used when the young transplants are set in the field.

For tomatoes, pepper, eggplants, melons and cucumbers, use fertilizer solutions high in phosphate, such as 10-52-10 or 10-50-10. Of this fertilizer, 4 lb (2.0 kg) are dissolved in 180 to 250 L (40 to 50 gal) of water, and each plant receives 115 mL (4 fl oz) of this solution at transplanting time.

For crops such as cabbage, cauliflower, and celery, a 20-20-20 fertilizer can be used at a slightly lower concentration than for tomatoes. Each plant receives 115 mL (4 fl oz) of this solution at transplanting time.

Use pesticides in starter solutions only if recommended by the manufacturer or if experience has indicated they are compatible.

FERTILIZER PLACEMENT AND APPLICATION

Following are brief descriptions of methods commonly used to apply fertilizer to vegetable crops.

Broadcasting

Refers to spreading a granular fertilizer on a soil surface before a crop has been seeded or planted. Incorporation into the soil follows broadcasting usually as part of seedbed preparation. Fertilizers are normally broadcast in the spring, however, may be fall applied. See previous sections on timing of fertlizer applications for limitation of fall applications.

Broadcasting is a relatively cheap method of applying fertlizers, however, it is not the most efficient method where rows are spaced far apart and plant
roots do not meet between rows.

Top dressing

Refers to spreading fertlizer on a field when a crop is growing. This fertilizer is not incorporated but may be irrigated to wash granules off the leaves to prevent burning. Normally restricted to nitrogen which can move into the soil quickly. Top dressing, banding and fertigation are primarily used to apply nitrogen to maturing crops when initial amounts of nitrogen may be low, yet the crop still has a high nitrogen demand.

Drilling

Refers to applying fertilizer near the seed in the same drill row or furrow. Applicators should be set so that as little fertilizer as possible is placed directly with the seed. Some mixing of seed, fertilizer and soil should occur. Phosphorus fertilizers are commonly applied to large seeded vegetable crops by drilling.

Banding

Refers to applying fertilizer in a continuous band to the side 5 cm (2 in.) and below 5 cm (2 in.) the seed at the time of planting. Banding is an efficient method of applying phosphorus fertilizer.

Side-dressing

Refers to banding fertilizers in the soil to the side of the crop row after plants are established. Care should be taken not to damage crop roots.

FERTIGATION

Fertigation is the process by which a fertilizer solution is placed in irrigation water. This process can be carried out by either the use of metering pump injectors that operate by means other than a pump. For small-scale applications, the fertilizer solution can be fed into an irrigation pump intake line by 'suction' or gravity. Either liquid or dry soluble fertilizer solutions can be used.

Advantages of fertigation include: close control over amounts applied; low application costs; ability to apply nutrients at any time according to crop needs; no mechanical damage to the crop; elimination of soil compaction; and uniform application when irrigation water is applied uniformly.

Disadvantages of fertigation include: higher cost of fertilizer, inconvenience of applying fertilizer at the start of each new irrigation set; potential corrosive damage to equipment if systems are not flushed after use; and lack of uniform nutrient application if irrigation water is not applied uniformly.

Information on fertigation can be obtained from Alberta Agriculture, irrigation division offices in Lethbridge, Brooks, Taber, Bow Island, Medicine Hat, Strathmore and Airdrie. The Airdrie regional agriculture office serves central and northern Alberta.

SECTION 4
IRRIGATION

IRRIGATION MANAGEMENT

Adequate irrigation produces top yields and high quality produce. The tubers and bulbs of some crops such as potatoes and onions will have a high dry matter content when they receive sufficient irrigation throughout the growing season. Excess or insufficient irrigation can cause delayed growth and maturity, and in some cases may encourage the development of disease or cause soil salinity to develop.

The amount and frequency of water applications depends upon the kind of crop, the stage of development of the crop, the water holding capacity of the soil, and the climate. Climatic factors include: temperature, sunlight, wind, precipitation and relative humidity.

Vegetable crops which have small seeds may require light and frequent applications of water to improve emergence of seedlings. This is particularly important where soil crusting is a problem. Light applications of water should wet the top layer of the soil (10 mm or 0.40 in. of water per application should be sufficient). If more water is applied it will increase the likelihood of crusting and will not keep the soil surface moist much longer than a light water application. Light water applications can be achieved successfully by using sprinkler irrigation systems. It is important to have a sprinkler system designed according to the needs of the crop to be grown. Proper sizing of sprinkler nozzles and operating at the designed system pressure will ensure a uniform application of water.

The depth from which crops can effectively draw moisture varies with the rooting depth of each crop. The allowable depletion of soil moisture varies with the crop and to a lesser extent the stage of crop development. Allowable depletion is the level of dryness that the plants can tolerate and still produce the desired yield. It is usually expressed as the percent of available moisture in the root zone. (See Table below). The available moisture in the root zone can be estimated by the feel method (Figure 4).

The timing of irrigation for a vegetable crop and the amount of water to be applied at each irrigation depends upon the rooting depth, soil texture and the amount of moisture stress the crop can tolerate. A shallow rooted crop like onions can effectively draw moisture from 0.6 m (2 ft). If the allowable depletion exceeds 35%, the yield is reduced. For example, a loam soil has 17 mm/0.1 m (2 in./ft) of moisture available for crop use or 102 mm (4 in.) in 0.6 m (2 ft) depth. Since the allowable depletion is 35%, then 36 mm (1.4 in.) of water can be removed from the root zone before an irrigation will be required. In mid-summer, the consumptive use of onions is about 5 mm (0.2 in.) per day. At this time an irrigation will be required every seven or eight days (assuming no rainfall occurs and normal crop growth and development is taking place) with a net application of 36 mm (1.4 in.) of water (Table 8) Carrots have an effective rooting depth of 0.9 m (3 ft) and have an allowable depletion level of 40%. If carrots were to be grown on a sandy loam soil, which has 13 mm/0.1 m of water available for crop use, in a 0.9 m root zone, 90 mm of water is available for crop use. Since the allowable depletion level for carrots is 40%, then 47 mm of water can be depleted from the root zone without putting the crop under stress. Moisture use by carrots will vary from 3 mm/day at the end of June to about 6 mm/day towards the end of July. Crop water use will increase with hot or windy weather and decline in cool periods. Weeds will increase water use. Typical seasonal water use is shown for potatoes in Figure 3.

The recommended allowable depletion for most vegetable crops is as little as 25% of available moisture for lettuce and as high as 50% for beans or

The available soil moisture for crop use varies with the soil texture.

Soil Texture	Available Moisture
Loamy sand	8-12 mm/0.1 m (0.9 - 1.4 in./ft)
Sandy loam	10-15 mm/0.1 m (1.2 - 1.8 in./ft)
Loam	14-18 mm/0.1 m (1.7 - 2.1 in./ft)
Sandy clay loam, clay loam, clay	15-20 mm/0.1 m (1.8 - 2.4 in./ft)
Silty clay loam, silt loam	16-22 mm/0.1 m (1.9 - 2.6 in./ft)

mm - millimetre, m - metre

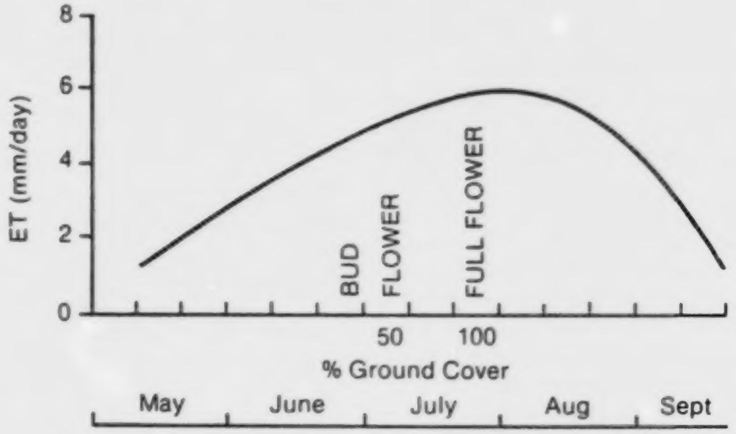


Figure 3. Evapotranspiration during the growing season.

		Feel or Appearance of Soils		
	PERCENT OF AVAILABLE MOISTURE REMAINING	**MODERATELY COARSE TEXTURE**	**MEDIUM TEXTURE**	**MODERATELY FINE TEXTURE**
DO NOT IRRIGATE	At field capacity 100	Upon squeezing no free water appears on soil but wet outline of ball is on left hand.	Same as sandy loam.	Same as sandy loam.
	75 to field capacity	Forms a weak ball, breaks easily, will not slide.	Forms a ball and is very pliable; slicks readily if relatively high in clay.	Easily ribbons out between fingers,has a slick feeling.
IRRIGATE SPEC. CROPS	50 to 75	Tends to ball under pressure but seldom will hold together	Forms a ball; somewhat plastic; will sometimes slick slightly with pressure.	Forms a ball, will ribbon out between thumb and forefinger.
IRRIGATE	25 to 50	Still appears to be dry, wil not form ball with pressure.*	Somewhat crumbly but will hold together from pressure.	Somewhat pliable, will ball under pressure.
	0 to 25	Dry, loose, single-grained, flows through fingers.	Powdery, dry, sometimes slightly crusted but easily breaks down into powdery condition.	Hard, baked, cracked; sometimes has loose crumbs on surface.

* Ball is formed by squeezing a handful of soil firmly.

Figure 4. Practical interpretation chart for available soil moisture.

Table 8. Irrigation scheduling for vegetables.

Crop Root Depth	Soil Water Holding Capacity	Available Moisture Held in Root Zone	Safe Depletion %	Moisture Safely Depleted	Daily Water Use	Irrigation Frequency
Onions .6 m (2 ft)	Loam 17mm/0.1 m (2.0 in./ft)	102 mm (4 in.)	35 (1.4 in.)	36 mm (0.2 in.)	5 mm	7 days
Carrots 0.9 m (3 ft)	Sandy Loam 13 mm/0.1 m (1.5 in./ft)	117 mm (4.5 in.)	40	47 mm (1.8 in.)	June 20 3 mm (0.6 in.)	16 days
Carrots 0.9 m (3 ft)	Sandy Loam 13 mm/0.1 m (1.5 in./ft)	117 mm (4.5 in.)	40	47 mm (1.8 in.)	July 30 6 mm (0.24 in.)	8 days

beets. The most critical period to avoid moisture stress is during seedling emergence and from flowering through seed formation, or during head, bulb or tuber development. The result of irrigating crops inadequately during the critical period is a lower yield and poorer quality produce.

METHODS OF IRRIGATION

The type of irrigation system chosen depends upon the topography, type of soil , water supply, crops to be grown, size of the project and the amount of capital and labor the farmer has access to. An estimate of capital, fuel and labor costs for a number of types of irrigation systems is given in Table 10. Some of the merits and limitations of a number of systems are discussed below.

Surface irrigation

Surface irrigation of vegetable crops is usually done by the furrow method. The design and layout depends on the crop to be grown, the slope of the terrain, the soil type and water supply.

With furrow irrigation only a part of the soil surface is flooded. Movement of water into the soil is both lateral and vertical. In most cases, irrigation of alternate furrows will give results almost equal to irrigating every furrow. From a practical standpoint, land slopes should be less than 2% and preferably less than 1% for efficient water application. In most cases, land levelling will be necessary so that low spots will be eliminated where water would otherwise pond.

For best water control, siphons or gated pipe can give furrow stream sizes that can be adjusted to fit the particular need. In addition, gated pipe eliminates seepage and weed problems associated with open unlined ditches.

Trickle irrigation

Trickle irrigation is well adapted to vegetable production particularly where the water supply is limited. Research has shown that water savings of 30% to 70% compared to furrow or sprinkler irrigation can be realized. Water is applied through a network of supply lines and laterals at a slow rate at or near the soil surface. Typical operation pressures are 70 to 200 kPa (10 to 30 psi). For vegetables, lateral tubing of either the double chamber or porous type is recommended to give a continuous wetting strip down the row. When the tubing is placed under a plastic mulch, large savings in water and weed control can result. The type of water filtration needed depends upon the initial water quality and the type of lateral used.

For many vegetable crops, a double row culture with one trickle line between the closely spaced double rows is recommended. This results in a higher plant population than in single row culture and reduces the amount of lateral trickle tubing required. The high capital costs of equipment will tend to limit the use of trickle in large field scale installations.

Sprinkler irrigation

Sprinklers have advantages, particularly to a vegetable grower, as they are adaptable to almost any soil or topographic condition, and can apply large or small amounts of water at one time. Sprinkler systems can also provide a light application to promote germination. However, the capital and operating costs of sprinkler systems are high.

Table 9. Irrigation requirements of vegetables.

Crop	Rooting Depth Metres (ft)	% Allowable Depletion of Available Moisture*	Comments
Beans (fresh market)	0.9 (3)	40	Beans are sensitive to moisture stress during the period of flowering to seed formation. A water-logged soil during flowering or pod formation stages will reduce seed yields and encourage the development of disease.
Beans	0.9 (3)	50	
Beets	0.9 (3)	50	
Broccoli and Cabbage	0.75 (2.5)	35	Broccoli and cabbage are sensitive to moisture stress at all stages but most sensitive at the time of head formation and enlargement.
Carrots	0.9 (3)	40	Several small applications of water near the time of emergence will aid in obtaining a uniform stand. Carrots are sensitive to moisture stress during the root enlargement period. In the fall, an excessively wet soil will encourage the development of soft rots.
Corn (sweet)	1.0 (3.2)	40	Corn is sensitive to moisture stress from tassel to seed formation stages.
Cucumbers	0.6 (2)	50	Available soil moisture should be kept above 60% after flowering begins.
Lettuce	0.6 (2)	25	Lettuce is sensitive to moisture during head formation. Excessive moisture in the seedling stage may cause seedlings to die off.
Onions	0.6 (2)	35	Irrigation water (light applications) may be needed early in the spring to aid the emergence of onions. Moisture stress during the bulb formation period will reduce the yield and the dry matter content. No watering after the third week of August to allow time for ripening of bulbs.
Parsnips	1.0 (3.2)	40	
Peas	0.6 (2)	30	Peas are most sensitive to moisture stress from the beginning of flowering-through pod formation. Peas are sensitive to water-logged soil.
Peppers	0.9 (3)	30	Moisture stress during flowering and fruit development will reduce yields.
Potatoes	0.8 (2.5)	30	Potatoes are sensitive to moisture stress from tuber formation until ripening of the vines begins. If the soil is kept moist at the time of tuber formation, this increases the number of tubers formed but reduces the average size of tubers. Late potatoes which do not suffer moisture stress will have a higher dry matter content than potatoes grown under an intermittent water supply.
Tomatoes	0.9 (3)	40	Tomatoes are sensitive to moisture stress from the time of flowering through to full enlargement of the fruit.

*A crop that has an allowable depletion of 25% of the available moisture will require irrigation twice as often as a crop that has an allowable depletion of 50%, if they have the same depth of rooting and daily water use. Available moisture is the water which is held in the root zone between field capacity and permanent wilting point. In general, vegetable crops are more sensitive to water deficiency during emergence, flowering and early yield formation than they are during early (vegetative) and late growth periods (ripening).

Table 10. Sprinkler irrigation costs, 1986 for quarter-section size fields, 300 mm (12 in.) application per season.

		Annual costs in dollars per acre				
System	Capital Cost/Acre	Fixed	Labor	Maintenance and Repairs	Fuel	Total
Wheel roll/2 laterals/ 8 hour sets	$240	35	7	3	10-28	54-72
Wheel roll/4 laterals/ 12 hour sets	$360	52	6	5	10-27	73-90
Center pivot	$475	69	2	7	8-22	87-100
Hard hose/traveller	$470	73	4	5	18-50	100-130

Hand move

Hand move systems made of portable aluminum tubing are best suited to small acreages such as market gardens. They can be used for germination, if the pressures are high enough to provide a finer droplet size. If light water applications are desired the lateral lines have to be moved often and this requires a lot of labor. In cases where the value of the crop warrants it, enough hand move laterals could be used to cover the entire field. This "portable solid-set" system would be laid out in the spring and left until fall when it could be removed. Frost protection is also possible with a solid set system. The labor involved would be the opening and closing of valves. The capital cost of the equipment would be very high compared to a portable hand move system. On small acreages, the pumping unit is the main initial cost of any system.

Wheel roll

Wheel roll systems are the most common sprinkler type in Alberta. For vegetable crops, four 400 m (1/4 mile) laterals per quarter section are required for high yield and quality. Where surface crusting is a problem or when irrigation for germination is required, the nozzle size of the sprinklers could be reduced to produce a finer droplet size. Equipment costs vary depending on the number of laterals required. Acreages smaller than a quarter section can also be irrigated with wheel roll systems, but the cost is higher and if the field is not rectangular labor requirements are greater.

Centre pivot

Centre pivot systems are also suited to vegetable crops provided a large area free of obstruction is available. Some operators have a quarter section pivot of which one-half or one-quarter of the circle is in vegetable crops. Shorter centre pivot machines are available and although the per acre cost is high they may be a viable alternative for vegetable crops. Major advantages of pivots are that they require a relatively small amount of labor, have the ability to operate on rough topography and have variable speed which permits light applications. Owing to the tracks made by centre pivot towers, a grower may want to harvest in a circle.

Travelling volume guns

Volume guns consist of one large sprinkler which may discharge between 100 and 500 US gallons per minute. These sprinklers can be set up and allowed to operate in one spot and then moved to a new location or else they may be self-propelled. These are known as travelling volume guns. (Because of the high application rates they may be harmful to tender young crops). Volume guns require a high operating pressure and therefore have high energy costs, but are very adaptable to odd shaped fields and to tall crops, even for tree nurseries.

Fertigation

Fertigation is the application of nutrients through an irrigation system. Refer to fertilizer placement and application in the soil management and fertility section.

Irrigation information

Details on developing an irrigation scheduling program, selecting and designing an irrigation system, soil evaluation for irrigation and drainage designs can be obtained from Alberta Agriculture, Irrigation and Conservation Division, Irrigation Branch. Offices are located in Lethbridge, Brooks, Taber, Bow Island, Medicine Hat, Vauxhall, Strathmore and Airdrie.

SECTION 5
VEGETABLE PRODUCTION RECOMMENDATIONS

This section lists specific crop recommendations for vegetable crops. Listed are accepted practices for each crop. It is not possible in a publication like this to cover all contingencies that may occur with any crop and growers who are faced with the unexpected are encouraged to contact their district agriculturist or crop specialist whose names are printed on the back cover. Processing vegetable crop growers should contact their contracting company fieldman.

Although many recommendations are based on research that has proven these to be the best methods, some of the recommendations are based on accepted practices in Alberta or other production areas.

Following are brief explanations of the recommendations that are made for each crop.

VARIETIES (CULTIVARS)

The varieties recommended are based on trials that have been conducted throughout the province. Over the past years there have been hundreds, and in some cases thousands of new varieties developed for each crop. The varieties that are recommended are those that have done the best out of the many that have been tested in Alberta. Growers who are starting a new crop should start with recommended varieties as the recommendations are based on accurate measurement of their performance.

SEED TREATMENT

Seeds should be treated to prevent decay in the soil and damping-off of young seedlings. Some seeds also require special treatment to kill fungi or bacteria that may be present in or on the seed. The two general methods of seed treatment are 1) a fungicide treatment (e.g. Captan) which protects against seed rot and 2) a hot-water treatment which kills organisms in or on the seed. These two methods are described in the pest control management section. Normally, all vegetable seeds can be purchased with a fungicide treatment, and where necessary (cabbages, rutabagas) hot-water treated seed is available.

SOIL

The two important aspects of soil are its physical and chemical properties. An important physical property is texture (sand, silt, clay). Important chemical properties of soil include pH (measure of acidity or 'sweetness'), and salinity. Nutrient supply is also an important chemical property and is discussed under fertilizers.

Important aspects of soil are discussed in the soil management and fertility section.

Generally, soil requirements are not presented in these recommendations and growers should refer to the section on soil management.

SEEDING

Many factors influence and affect the seeding of vegetable crops. Not all are listed in the recommendations because of wide variations within the province. Some aspects of seeding include: soil temperature, soil moisture, seeding depths, seeding dates, and seeding rates.

Minimum soil temperatures are listed in the recommendations. Generally, seeds will not germinate below these temperatures and at these minimum temperatures seeds germinate slowly. Crops should be seeded into moisture where possible. Often small seeded crops are planted shallow into dry soil. Rain or irrigation is required for germination and emergence. Moisture recommendations for emergence are not listed in recommendations. The seeding depth recommendations should be followed as closely as practical, but may be influenced by moisture, soil type and other factors.

Seeding dates for vegetable crops vary greatly because of location or because of desired time of harvest. Generally, crops should not be seeded before soil temperatures reach minimum requirements.

Seeding rates listed in the recommendations are guides only. There are normally wide variations in seed size and spacing requirements which can affect seeding rate. Spacing requirements (see below) will vary because of climate, moisture, variety and equipment available.

SPACING

Spacing requirements are based on several factors. These include: space requirements of the crop in order to produce the required end product; type of seeding, cultivation and harvest equipment available; availability of irrigation or natural moisture; and, availability of chemical weed control.

Plant spacing or plant population will influence the growth and final outcome of vegetable plants. Between-row and in-row spacing can affect yield per acre, percent marketable, size and shape of vegetables and their maturity. Crops where in-row spacing can greatly influence size include: carrots, rutabagas, onions, beets, potatoes, cabbage, broccoli, cauliflower, lettuce, and parsnips.

Between-row spacing is important because the spacing must allow for movement of cultivating, spraying, harvesting equipment and manual workers.

The spacing recommendations in this guide are based on two sources. These are 1) research which has proven optimum spacings and 2) common practice which is based on tradition and equipment available. Even where specific research for Alberta conditions is lacking, the recommendations listed should result in thebest yields based on current technology.

Growers are urged to follow these spacing recommendations as closely as possible and adjust equipment if necessary to suit these optimum spacings. Growers may wish to modify spacings when many crops are grown in order to reduce continual machinery readjustment. Keep modifications within reasonable limits.

SPECIAL NOTE: Traditional or accepted spacing recommendations are being reviewed by research institutions. Recommendations often change as a result. General findings of spacing research are that marketable yields are usually higher at higher populations. Growers are often limited in the row spacings they use by lack of chemicals for weed control, lack of moisture, and the need for wide row spacings to allow for harvest equipment.

FERTILIZER

The recommendations listed are to be used as guides only. Growers should soil test every year. The small fee charged for a soil test can more than pay for itself through increased yields where fertility is low or through fertilizer savings where fertility is high.

Fertilizer recommendations are based on research conducted in Alberta, or on a consensus of recommendations from other production areas. Normally, nitrogen and phosphorus are the only fertilizers required in Alberta. Potassium is normally quite high in most Alberta soils and has not shown consistent results in fertilizer tests. Recommendations for potassium have not been made, but this nutrient may be required in some areas as shown on soil test reports.

If possible growers can band nitrogen and phosphorus near the seed rows. The amount of fertilizer used can be reduced if it is banded. The benefits of banding depend on plant populations used. Where narrow row spacings are used the benefits of banding are decreased and fertilizer can be broadcast.

Growers are urged to soil test and base fertilizer applications on the results of these tests.

WEED CONTROL

The chemicals listed in this guide are registered for the stated use. There may be other products that are registered but not listed. It is illegal to use chemicals that are not registered for specific use.

The chemicals recommended are registered for use in Alberta. **Rates are in amount of ACTUAL PRODUCT**. Most herbicides are applied in 90 to 180 litres per acre (225 to 450) litres per hectare unless otherwise noted. FOLLOW INSTRUCTIONS ON THE LABEL. Generally herbicides do not control all weeds and growers should be fully aware of potential weed problems and be prepared to control them accordingly through crop rotation and cultivation.

The specific weeds controlled by each chemical have not been listed. Check Table 1 or the weed control specialist listed on the back cover of this publication for more detailed information on application and specific weeds controlled. Product labels list application methods and weeds controlled.

Because of the relatively small acreage of many vegetable crops, either in Alberta or on an international scale, chemicals have not been developed for all crops. A number of herbicides registered for use in the U.S. are not registered in Canada because of their limited market. The development, testing and registration process is a long and costly procedure which often cannot be justified by chemical companies because of limited economic potential. Where chemicals are not registered for use on a specific crop, growers must use both crop rotation and cultivation to control weeds. An added method is to use contact herbicides for the stale seedbed method (see page 18) before crop emergence and to use contact herbicides around crop areas after crop emergence. Whatever herbicide is used, vegetable producers are advised to order their supply well in advance of anticipated use.

INSECT CONTROL

The chemicals listed in this guide are registered for the stated use. There may be other products that are registered but not listed. It is illegal to use chemicals that are not registered for a specific use.

All pest control chemicals are toxic, however, insecticides generally are more toxic to man than other pesticides. FOLLOW THESE

RECOMMENDATIONS AND THOSE ON THE PRODUCT LABEL. **Chemical rates recommended are given as the amount of ACTUAL PRODUCT.** Consult the insect control specialists listed on the back cover of this guide or company representatives if more detailed information is required.

The 'number-of-days-to-harvest' follows each recommendation, for example: (7 days). This means the chemical should not be applied within seven days of harvest. Some products, e.g. **Thiodan** and **Lorsban**, have restrictions on feeding crops or crop refuse to livestock after treating with these products. Check all labels for such restrictions before use.

DISEASE CONTROL

The diseases discussed are those that have caused crop injury in Alberta. Chemicals listed for control are registered for use in Alberta. Most crops can be attacked by numerous diseases, if a pathogen source is present and environmental conditions are right. Not all potential disease problems are covered in this guide. Consult the nearest plant pathologist listed on the back cover of this guide for more detailed information on diseases. Growers must recognize the importance of crop rotation and sanitation in the prevention of crop disease. **All recommendations are given as the amount of ACTUAL PRODUCT unless otherwise noted.**

STORAGE

All vegetable crops have at least some storage life. The recommendations listed are those that will help maintain quality for the maximum amount of time. The two critical factors in storage management are temperature and relative humidity.

The best storage conditions cannot prolong the storage life or improve the quality of vegetable crops that are of poor quality to begin with. Damaged and diseased crops cannot be stored for long periods. Storage life is also affected by the rate at which the initial field heat is removed from the crop.

Refer to Section 1 of this guide for more details on storage construction and storage requirements.

GRADE STANDARDS

Grade standards are regulated by both the federal and provincial governments. Not all vegetable crops are governed by grade regulations, however, where no legal regulations exist a grower must only offer top quality produce for sale that is fresh, free from blemishes, diseases and insects.

The grade standards listed in the recommendations are intended only as a guide and have no official sanction. Producers should consult the Canada Agricultural Products Standards or contact the nearest Agriculture Canada office of the fruit and vegetable inspection division. In most cases, Alberta regulations are the same as the federal regulations. There are some exceptions where a special provincial grade may be packaged and offered for sale within the province of Alberta.

All produce must be packaged according to the regulations. Both grade and packaging regulations are reported in Fresh Fruit and Vegetable Regulations available from :

Canadian Government
Publishing Centre
Supply and Services
HULL, QUEBEC
K1A OS9.

ASPARAGUS

Varieties

Viking selections

Soil

Fertile, well drained loam to sandy loam.

Planting from seed

Growers may produce crowns from seed, or purchase one-year-old crowns if available.

If planted from seed, asparagus can be planted in a temporary location for one year to save space or it may be planted in the permanent location. While the latter uses more space for one year, it does save moving the plants the following spring.

One kilogram (0.5 lb) of seed should produce about 20,000 plants per hectare (8,000 per acre), however, only strong plants should be used when transplanting for as many as one half of the seedlings may be discarded because of weakness, disease, etc.

Seed when soil is above 15°C. For transplant stock which will be moved, sow seed 2-3 cm (1-1.5 in.) deep, with 10-15 cm (4-6 in.) between plants and 60 cm (2 ft) between rows.

If seeds are to be planted in their permanent location, sow seeds 2-3 cm (1-1.5 in.) deep in a furrow 15-20 cm (6-8 in.) deep at 12 seeds per metre (4 seeds per foot). The furrow should be 1.2 metres (4 ft) apart. Thin to 30 cm (12 in.) apart in the row when emergence is complete. Fill in the furrows gradually as the plants grow.

Planting from established plants

In early spring of the year following seeding, dig the year-old plants, discard the weak plants, and plant vigorous crowns 2-5 cm (1-2 in.) deep in a 20 cm (8 in.) deep furrow. Strong plants should have at least 10 roots. Space the plants 30 cm (12 in.) apart in furrows 1.2 metres (4 ft) apart. Spread the roots and cover with not more than 5 cm (2 in.) of well firmed soil. Fill in the furrows as the plants grow during the second growing season until the furrows have been filled level with the field. Keep the asparagus bed free from weeds at all times.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Asparagus is a deep rooted perennial that requires adequate nutrient levels at the root zone. It is necessary that nutrient levels, expecially of phosphorus, be adequate prior to planting. Phosphorus moves down slowly in the soil and it will take several years for phosphorus added on the surface to move into the root zone where it can be used.

The summer or fall prior to establishing an asparagus field a heavy 18 t/ac (45 t/ha) application of well rotted manure should be applied.

Prior to planting, apply and work in 135 kg/ac (340 kg/ha) of 11-55-0 and 90 kg/ac (225 kg/ha) of 34-0-0 or the equivalent.

Reduce fertilizer amount as indicated by the soil test.

Each spring apply the following to established plants: 90 kg/ac (225 kg/ha) of 34-0-0 and 45 kg/ac (110 kg/ha) of 11-55-0 or the equivalent.

Each fall after cutting an established planting, apply 40 kg/ac (100 kg/ha) of 34-0-0. Broadcast and work in lightly. Allow ferns to develop after application. The nitrogen may also be added through the irrigation water.

Check fertility levels with annual soil tests.

Apply 10 t/ac (23 t/ha) of well rotted manure every 3 to 4 years.

Weed control

Perennial weeds should be completely eradicated prior to planting or seeding asparagus. These weeds are difficult to control with chemicals and deep cultivation may damage the asparagus crowns.

If started from seed, Gramoxone (paraquat) should be applied a few days before the seedling emerges to destroy weed growth. (See Stale Seedbed.) Later on, control can be aided by burial as the furrows are gradually filled in.

Established asparagus

Before the first cutting:

Princep Nine-T (simazine) at 1.0 to 1.5 kg/ac (2.5 to 3.75 kg/ha) or **Simadex** flowable (500 g/L) at 1.8 to 2.7 L/ac (4.5 to 6.7 kg/ha) or **Simadex 80W** at 1.1 to 1.9 kg/ha 2.75 to 4.25 kg/ha) of product in at least 120 L/ac (300 L/ha) of water for control of annual grasses and some broadleaf weeds (Table 7, p. 32). Apply after disking in spring, prior to weed and spear emergence and at least 7 days prior to first cutting. Keep spray mixture constantly agitated. Apply only once per year. Use lower rates on sandy or loam soils. Rainfall is necessary to activate simazine.

Afolan F (450 g/L), **Lorox L** (480 g/L) controls numerous broadleaf weeds and suppresses green foxtail and barnyard grass (Table 7, p. 32). Apply **Afolan F** at 1.5 to 2.0 L/ac (3.7 to 5 L/ha) or **Lorox L** at 1.4 to 1.8 L/ac (3.4 to 4.5 L/ha) in 120 L/ac (300 L/ha) of water. Irrigation or precipitation is required after application to activate the herbicide.

Karmex 80W (diuron). Apply only to established plants as a band or broadcast treatment. On sandy soils and others low in clay or organic matter, use 0.44 to 0.9 kg/ac (1.1 to 2.25 kg/ha). On soils high in clay or organic matter use 0.9 to 1.8 kg/ac (2.25 to 4.5 kg/ha). Two applications may be used, the first application should be made before weeds become established and before spears emerge; a second application may be made immediately after harvest. When two applications in one season are made, do not exceed 1.3 kg/ac (3.25 kg/ha). If irrigation is used, apply on a single treatment of 1.8 kg/ac (4.5 kg/ha) in late September or October.

MCPA or 2,4-D Amine. Apply 2,4-D amine 500 or MCPA amine 500 at 1.4 L/ac (3.5 L/ha) or MCPA potassium and sodium salt (300 g/L) at 2.2 L/ac (5.5 L/ha) in 40 L/ac (100 L/ha) water. Can be applied after discing just before spears appear. Treatment may be repeated at end of cutting season. MCPA or 2,4-D controls a wide spectrum of broad-leaved weeds.

Gramoxone 200 g/L (paraquat). Apply at 1.1 to 2.2 L/ac (2.75 to 5.5 L/ha) in 120 to 445 L/ac (300 to 1100 L/ha) of water for "chemical mowing" of emerged annual weeds and top growth control of perennial weeds prior to cutting. Use higher rate when weeds are above 5 cm (2 in.) in height and the higher water volume when weed growth is dense. Do not apply to spears; if treated accidentally, these spears should not be used for human consumption. This treatment may be repeated after cutting

After last cutting:

Amitrol-T 200 g/L (amitrole). Apply at 9.0 to 14.2 L/ac (see label for specific details) (22 to 35 L/ha) in a minimum of 80 L/ac (200 L/ha) of water. Amitrol-T may be used as a spot treatment to control patches of perennial weeds. Application should be made when the weeds are actively growing. Avoid hitting the asparagus leaves with Amitrol-T as much as possible.

Gramoxone. See above.

2,4-D, MCPA. See above.

Afolan, Lorox. See above.

Karmex. See above.

Basfapon (74%), **Dalapon** (74%), **Dowpon** (74%), **Dowpon M** (74%). Controls barnyard grass, green and yellow foxtail. Apply **Basfapon** or **Dalapon** at (1.3 to 2.7 kg/ac (3.25 to 6.75 L/ha) product in 80 L/ac (200 L/ha) water or **Dowpon** or **Dowpon M** at 1.37 to 2.75 kg/ac (3.4 to 6.8 kg/ha) product. Apply after cutting before grasses are at the four leaf stage.

To control quack grass in established asparagus apply **Dalapon, Dowpon** or **Dowpon M** at 4.45 kg/ac (11 kg/ha) product before cutting and again about three to four weeks later as needed. For a single treatment apply **Dalapon** at 9.0 kg/ac (22.5 kg/ha) product or **Dowpon** or **Dowpon M** at 9.0 kg/ac (22.0 kg/ha) product before or after the cutting season.

Or to control quack grass apply **Basfapon** at 6.0 to 9.0 kg/ac (14.5 to 22.5 kg/ha) product in 80 to 162 L/ac (200 to 400 L/ha) water after a cutting at one week before close of the cutting season or in October after fern removal. Disc the field after last cutting. Do not make more than one application of Basfapon per season.

Insect control

Asparagus aphid

Green aphids produce 'witches' broom' type of growth and numerous thin spears. Limited distribution as yet. Destroy or burn old fern growth. Apply one of the following foliar sprays:

Phosdrin 60 SN at 182 mL/ac (450 mL/ha) (1 day) - Repeat as necessary, or **Rotenone 5 WP** at 4 to 5 kg/1000 L (4 to 5 lb/100 gal) (1 day) - Repeat at 5-7 day intervals as necessary.

Disease control

Crown rot (Fusarium) and seedling blight

Avoid introducing the disease to new land by using treated seed or crowns believed to be free of disease. There is less risk of introducing the disease if growers raise their own crowns from seed on clean land.

Soak asparagus seed for two hours in a bleach solution mixed at a ratio of 1 L Chlorox (household bleach) in 5 L (1.5 pints in 1 gallon) water. The seed must be lifted and shaken periodically.

Treat crowns before planting with **Benlate 50 WP** at 2.0 g/L (0.32 oz/gal). Dip 3000 crowns in 100 L (20 gal) of this solution for 15-20 minutes. Do not cultivate deeper than 10 cm (4 in.). Rotate affected fields with grasses or cereals. If disease free soil is not available for growing seedlings, fumigate seedbed before planting with **methyl bromide*** or **Vorlex***. Consult manufacturer's directions before use. Follow all safety precautions.

***CAUTION, VERY TOXIC.**

Rust

Grow plants in areas with good air circulation. Destroy volunteers in and near asparagus fields. Irrigate early in the day so that plants do not remain wet overnight. The commonly available variety, Viking 2K has a good to fair level of resistance. After harvesting has been completed for the year, but before disease normally appears, spray fern growth every 10-14 days as required with **Zineb 80WP** at 1.3 kg/ac (3.25 kg/ha) or **Polyram 80WP** at 1.3 kg/ac (3.25 kg/ha).

Special problems

Harvesting

Harvesting may be done on a limited scale in the third year after seeding or a second year after planting one-year-old crowns.

In the first harvest year cut only large good quality spears when about 12-20 cm (5-8 in.) high, and only for about 2-3 weeks. In the second cutting year, harvest about 3 to 4 weeks only, and in the third and subsequent cutting years harvest for no longer than 4 weeks. In southern areas, where more growth accumulates after harvest, asparagus may be cut for up to 6 weeks.

Excessive cutting in any season may seriously reduce crown vigor and result in reduced yields the following year. If this does occur, shorten the cutting season that year to let the crowns build up reserve food to ensure a vigorous growth of spears the following year.

The spears should be harvested about twice a week. However, during hot weather a daily harvest may be required because the spears grow rapidly.

Postharvest field care

After the cutting season broadcast 45 kg/ac (110 kg/ha) of 34-0-0 and work in to the top 5 cm (2 in.) of soil. Irrigate and allow ferns to develop for the remainder of the summer and fall. Let ferns stand throughout the winter. The old stalks can be disced down the following spring either before or after fertilization.

Storage and handling

Asparagus is extremely perishable and is normally marketed directly after harvest. It should be placed in storage only as a temporary measure if it cannot be marketed immediately.

Asparagus should be cooled to 0°C immediately following harvest and held at a humidity exceeding 95%. Under these conditions storage life can be extended up to 3 weeks. After 3 weeks of storage, shelf life is short.

Grade and packaging standards

The following is a guide and has no official sanction.

Generally Canada No. 1 asparagus is fresh; has smooth evenly cut ends; is free from specimens having tips that are broken, spreading or having seedy appearance; is free from decay and free from injury and blemish; has not more than 15% of each stalk white; has stalks of a minimum diameter of 0.8 cm (5/16 in.) and a minimum length of 14 cm (5.5 in.) and when packaged do not vary more than 3.0 cm (1.5 in.) in length.

Canada No. 2 asparagus is free from decay, free from injury or defect that seriously affects appearance, edibility or shipping quality and has no more than 15% of each stalk white. Overall general tolerances are also specified. No specific package sizes are required.

BEANS

Varieties

Fresh market green beans: Tendercrop, Topcrop, Bush Blue Lake 94, Savor, Shamrock, Strike, Flo, Peak.

Fresh market wax beans: Eastern Butter Wax, Goldrush, Earliwax, Key Gold.

Process market: as required by processor.

Dry beans: Pinto 111, Fiesta (pinto); Seafarer, Snowflake (small white); Red Mexican 36, Garnet (small red); Viva, Harold, Victor (pink); Great Northern 1140 (large white).

Broad beans: Broad Windsor, Exhibition Long Pod.

Seed treatment

Purchase fungicide-treated seed or treat seed with either Captan or Thiram seed treatment.

Seed and spacing

Snap beans. Snap beans will germinate at temperatures above 15°C. Beans may suffer from extensive seed rot if planted into soil colder than 15°C.

Bean seeds crack easily and should be handled with care. The seeder or planter should not crack or split the seed.

Seeds should be placed about 3-5 cm (1.5-2 in.) deep.

Snap beans grown for processing must be planted in rows that are matched to the mechanical harvester used. Spacing and seed rates are given by the processor.

Beans grown for fresh market are normally hand harvested and grown in rows 60-90 cm (24-36 in.) apart. Seed is placed 3-5 cm (1.5-2 in.) apart in the row. About 30 kg/ac (80 kg/ha) of seed are required.

Dry beans. Seed handling and planting requirements are similar to snap beans. Row spacings are governed by harvesting equipment. Normal spacings are 60 cm (24 in.) between rows and 5-7 cm (2-3 in.) within the row. About 20 to 30 kg/ac (50-80 kg/ha) of seed are required.

Broad beans. Broad beans can be planted into cooler soil than snap or dry beans. Good emergence can be expected when the soil temperature is above 10°C. Broad beans are grown in rows 90-100 cm (36-

40 in.) apart and with about 7-10 cm (3-4 in.) between plants. About 100 kg are required per 100 metre of row (65 lb/100 ft of row) or about 70 kg/ac (170 kg/ha).

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Beans are legumes and have the ability to use nitrogen from the air provided the necessary soil organisms are present. All bean seed should be treated with an inoculant that adds organisms to the soil which help the plants to fix nitrogen.

Broadcast and work in prior to planting 20 kg/ac (55 kg/ha) of 11-55-0 and 45 to 55 kg/ac (110-140 kg/ha) of 34-0-0 or the equivalent.

The amount of nitrogen required will be less in soils where beans have grown before and there are sufficient soil organisms established that will fix more nitrogen in the soil. Drill about 20 kg/ac (55 kg/ha) of 11-55-0 near the seed rows at seeding time.

Adjust fertilizer application as indicated by soil test results.

Weed control

To provide broad spectrum weed control, it is generally necessary to use a preplant incorporated (PPI) herbicide. A followup application with a pre-emergence or postemergence herbicide may be required to control 'escape' weeds.

Preplant incorporated

Eptam 8-E (800 g/L), **Eptam 10 G** (10%). Controls annual grasses and general broadleaf weeds (Table 7, p. 32). Apply in the spring at 1.7 to 2.2 L/ac (4.25 to 5.5 L/ha) or 13.75 to 18.2 kg/ac (34 to 45 kg/ha) granular product. Liquid should be applied on a dry soil surface in at least 40 L/ac (100 L/ha) water. Use a suitable granular applicator for the granular product. Incorporate immediately following label instructions. Do not use **Eptam** or Adzuki beans, cow peas, soybeans, lima beans or other flat podded beans except Romano.

Treflan 545 EC (545 g/L), **Rival** 500 g/L, **Triflurex** 400 g/L (trifluralin). Controls annual grasses and broadleaf weeds (Table 7, p. 32).

1. Spring Application. **Treflan** 545 g/L EC at 0.8 L/ac (2.0 L/ha) on all medium and heavy textured soils and sandy soils with greater than 6% organic matter. 0.6 L/ac (1.5 L/ha) **Treflan** 545 EC on sandy soils with less than 6% organic matter. On medium and heavy textured soils with high organic matter content (6-15%) and with heavy wild oat infestations, apply **Treflan** 545 EC at a rate of 1.0 L/ac (2.6 L/ha).

Triflurex 400 g/L EC at 1.1 L/ac (2.75 L/ha) on all medium and heavy textured soils with greater than 6% organic matter and 0.8 L/ac (2.0 L/ha) on sandy soils with less than 6% organic matter.

Rival (500 g/L) EC at 650 mL/ac (1.6 L/ha) on sandy soils less than 6% organic matter and at 890 mL/ac (2.2 L/ha) on medium or heavy textured soils, 6 to 15% organic matter.

2. Fall Application - between September 1 and freeze-up.

Treflan 545 EC at 0.8 L/ac (2.0 L/ha) on sandy soils with less than 6% organic matter. On medium and heavy textured soils with high organic matter content (6-15%) and with heavy wild oat infestations, apply Treflan 545 EC at a rate of 1.0 L/ac (2.6 L/ha).

Triflurex 400 g/L EC. 1.4 L/ac (3.5 L/ha) **Treflan 400 EC** on all medium and heavy textured soils and on sandy soils with greater than 6% organic matter. Apply **Triflurex** at 1.1 L/ac (2.75 L/ha) on sandy soils with less than 6% organic matter.

Rival 500 g/L EC at 890 ml/ac (2.2 L/ha) on sandy soils with less than 6% organic matter or at 1.1 L/ac (2.7 L/ha) on medium or heavy textured soils with 6 to 15% organic matter.

Apply trifluralin products in at least 40 L/ac (100 L/ha) of water. They must be incorporated into the soil in two different directions or in one direction with a rotovator. Incorporation can also be accomplished with a tandem disc, disker or field (vibrashank type) cultivator set to work 8 to 10 cm (3 to 4 in.) deep. First incorporation must be done within 24 hours of application. As a precautionary measure, do not plant red beets, sweet corn, vine crops, oats and small seeded annual grasses in rotation following the use of trifluralin. Fall incorporations should be done during September to freeze-up. Do not apply trifluralin in the fall if the soil is prone to wind erosion.

Postemergence

Basagran (480 g/L bentazon). Controls several broadleaf weeds (Table 7, p. 32). Apply 0.7 to 0.9 L/ac (1.75 to 2.2 L/ha) in 80 to 160 L/ac (200 to 400 L/ha) water. Apply after the first trifoliate leaf stage. Use the higher rate on redroot pigweed taller than 3.5 cm (1.5 in.), for annual smartweed species more than 7.5 cm (3 in.) and for cocklebur taller than 17.5 cm (7 in.). The addition of Assist oil concentrate at 810 mL/ac (2 L/ha) to the spray mixture will improve the control of advanced weeds. Best results are obtained if **Basagran** is applied under higher temperature conditions (21°C, 70°F) and weeds are young and actively growing. Basagran is a contact herbicide; it must therefore be applied with adequate pressure to give good coverage of the foliage. A split application is recommended for top growth control of Canada thistle.

Currently, registration for **dinoseb amine** products has been suspended. Growers who have dinoseb amine in storage can use the product in accordance with the label.

Premerge 360 g/L, Sinox PE (360 g/L), Yellow Stuff PE (360 g/L). Controls wild mustard, stinkweed and volunteer rapeseed. Apply 3.2 to 5.6 L/ac (8 to 14 L/ha) in 100 to 160 L/ac (250 to 400 L/ha) water. Apply at emergence or shortly after, but not beyond the crook stage. Late applciation will result in delayed maturity and yield reduction. CAUTION: Use rubber gloves, goggles and agricultural respirator when handling Premerge 360, Sinox PE, Yellow Stuff PE.

Hoe-Grass 284 (284 g/L diclofop methyl) at 1.4 L/ac (3.5 L/ha) for the control of wild oats, green and yellow foxtail, Persian darnel, barnyard grass and volunteer corn. Apply in 45 L/ac (110 L/ha) at 275 kPa (40 psi) with the spray at a 45° angle forward. Apply Hoe-Grass when the majority of the grass weeds are in the 2 to 3 leaf stage (usually at 10 to 16 days after emergence).

Poast (184 g/L sethoxydim) maximum recommended rate for snap beans is 0.77 L/ac (1.9 L/ha). Timing of application should be based on stage of grass weeds. See table below for recommended rates and optimum leaf stages.

For ground application, use sprayers equipped with 80° flat fan nozzles, with the nozzles tilted 45° forward to ensure better coverage. In general do not exceed water volumes of 45 L/ac (110 L/ha) and use a minimum pressure of 240 kPa (35 psi). Higher spray pressure is required for quack grass and dense weed infestations or crop canopies.

For band applications, rates per acre should be adjusted in relation to the band width. Quack grass should be treated as broadcast (overall) applications only.

Allow four days between application of Poast and any other chemical not recommended as a tank-mix combination on the label.

Grass Species	Optimum Grass Leaf Stage	Grass Plant Height (cm)	Product Rate mL/ac (L/ha)
Green & yellow foxtail (wild millet), barnyard grass, volunteer corn, proso millet & Persian darnel; for extremely heavy infestations of these annual grasses use 405 mL/ac (1 L/ha).	2-5	10-15	One repeat application if necessary for second flushes of weeds (onions only).
Wild oats (plus annual grasses listed above); for extremely heavy infestations of wild oats use 650 mL/ac (1.6L/ha).	2-5	10-15	570 (1.4)
Volunteer spring wheat, barley & oats (plus annual grasses listed above); for extremely heavy infestations of volunteer barley, use 770 mL/ac 1.9 L/ha).	2-5	10-15	650 (1.6)
Quack grass plus annual grasses listed above (do not use this rate in snap beans).	up to 3	8-12	1.78 L/ac (4.4) (followed by a cultivation 7 days after treatment in wide row crops).

Assist oil concentrate must be added to the spray solution as follows:

20 to 45 L/ac (50 to 110 L/ha)	200 to 400 mL/ac **Assist** (0.5 to 1 L/ha)
45 to 50 L/ac (110 to 200 L/ha)	810 mL/ac Assist (2 L/ha)
Aerial applications:	
10 to 20 L/ac (25 to 50 L/ha)	200 to 400 mL/ac **Assist** (0.5 to 1 L/ha)

Insect control

Aphids

Usually black or green species feeding on growing tips and leaf undersides.

Apply one of the following foliar sprays: **Malathion 50 EC** at 800 mL/ac (2.0 L/ha) (1 day) - Repeat as necessary, or **Cygon** 4 E **(Lagon, System)** 48 EC at 220 to 400 mL/ac (550 to 1000 mL/ha) (7 days) - Repeat as necessary, or ***Thiodan (Endosulfan)** 50 WP at 445 to 600 mL/ac (1.1 to 1.5 kg/ha) (2 days), or **Phosdrin 60 SN** at 180 mL/ac (450 mL/ha) (1 day) - Repeat as necessary.

Alternative chemicals and formulations: **Thiodan 4E 40 EC** (2 days); **Malathion 4 DU, 25 WP** or **85 EC** (1 day); **Systox 24 EC, 72 EC** (21 days), **Diazinon 50 EC, 50 WP** (3 to 14 days); **Di-Syston 15G, 72 EC** (60 days); **Guthion 50 WP, 12 EC, 24 EC** (3 days); **Dibrom 86.4 ED** (4 days); **Thimet 10G, 15 G** (60 days); **Rotenone 5 WP, 5 DU, 1 DU** (1 day).

*Do not use on lima beans.

Spider mites

Tiny, sap-sucking mites on leaf undersides causing yellowing. Usually only a problem near urban areas.

Apply one of the following foliar sprays: **Phosdrin 60 SN** at 180 mL/ac (450 mL/ha) (1 day) - Repeat as necessary, or **Systox 24 EC** at 700 to 910 mL/ac (1.72 to 2.25 L/ha) (21 days) - Repeat as necessary, or **Dibrom 86.4 EC** at 445 to 890 mL/ac (1.1 to 2.2 L/ha) (4 days) - Repeat as necessary.

Alternative chemicals and formulations: **Systox 72 EC** (21 days); **Cygon 4E 48 EC** (7 days); **Di-Syston 15G, 72 EC** (60 days); **Malathion 4 DU, 50 WP, 50 EC, 85 EC** (3 days); **Thimet 10G, 15G** (60 days); **Kelthane 18.5 EC** (7 days).

Thrips

Tiny black, rasping insects on leaves and flowers cause silvering and bud blast if very numerous.

The following materials applied at seeding should provide some thrips control: **Di-Syston 72 EC** at 0.6 to 1.3 L/ac (1.5 to 3.25 L/ha) (60 days), or **Thimet 10G** at 4.5 to 7.0 kg/ac (11 to 17 kg/ha) (60 days).

Although not specifically registered for thrips control on beans, **Phosdrin 60 SN** at 180 mL/ac (450 mL/ha) (1 day) should give control if necessary near harvest.

Seedcorn maggots

Small whitish, headless maggots which attack germinating bean seeds and tunnel them out.

Treat seed with diazinon-captan or diazinon-lindane mixtures according to manufacturers' directions or buy pre-treated seed, if available.

Disease control

Bacterial blights (Common and Halo)

Use only disease-free seed. Plow under crop refuse promptly after harvest. Follow a 3-year rotation out of beans. Do not work in fields when foliage is wet. Furrow irrigation is preferred. Apply **Kocide 101 77 WP** at 0.9 to 1.3 kg/ac (2.2 to 3.3 kg/ha) (1 day) or **Chem Cop 53 WP** at 2.3 kg/ac (5.6 kg/ha) (1 day) or **Tri Cop 53 WP** at 2 to 3 kg/ac (5-6 kg/ha) (1 day) at first sign of disease. Resistant varieties are available for some types of bacterial blights. Chemical control may not be practical except for small seed plots or other special situations.

Dry root rot

Plant fresh, vigorous seed. Subsoil heavy clay soils prior to planting. In fields where root rot is known to be a problem, cultivate and fertilize to obtain maximum growth. Plow down crop refuse promptly after harvest. Follow a long rotation with cereals, beets, onions, or corn. Varieties vary from very susceptible to moderately resistant with most of the common varieties being intermediate in tolerance.

Gray mold

Maintain air circulation through the plant canopy by providing good weed control and avoiding dense, lush growth. Avoid long periods of overhead irrigation, particularly during flowering. Apply **Botran 75 WP** at 1.3 kg/ac (3.3 kg/ha) (2 days), or **Benlate 50 WP** at 0.9 kg/ac (2.2 kg/ha) (14 days), or **Rovroal 50 WP** at 0.6 kg/ac (1.5 kg/ha). Thorough coverage of blossoms is essential. In fields where **Benlate** has been used extensively in the past, poor control may result because of a high level of tolerance in the gray mold fungus.

Mosaics

If common mosaic virus is a problem, select resistant varieties. Most seed catalogues give the status of common mosaic resistance for each variety. Avoid bean yellow mosaic by planting beans at least 1 km (0.5 mile) away from sweet, crimson or red clover or gladioli which may carry the virus. Aphid control may reduce rate of spread.

Rust

Plow under crop refuse after harvest. Follow a 3-year rotation. Most bush beans are resistant to rust.

Where early infections occur, applications of sulphur 92 WP at 2.7 to 3.6 kg/ac (6.7 to 9.0 kg/ha) (1 day) at 7-day intervals up to blossoming may be warranted.

Stem rot (White mold)

Avoid dense foliage by restricting nitrogen fertility and moisture levels. Rotate with nonsusceptible crops such as beets, onions, spinach, corn, cereals and grasses. Furrow irrigation is preferred. If using sprinklers, do not apply excess water or irrigate in late afternoon or evening. Apply **Benlate 50 WP** at 0.7 to 0.9 kg/ac (1.75 to 2.25 kg/ha) (14 days), or **Botran 75 WP** at 1.3 kg/ac (3.3 kg/ha) (2 days) just prior to full bloom. Thorough coverage of blossoms is essential.

Storage and handling

Snap beans, if cooled immediately after harvest and held at 7°C, can be stored for 8-10 days; humidity should be maintained about 90%. Beans are subject to chilling injury, and temperatures below 7°C should be avoided. DO NOT top-ice beans. Beans should be properly hydrocooled to remove field heat after harvest.

Grade and packaging standards

There are no federal grade or packaging standards for fresh market beans in Canada. Growers should only market fresh beans free from disease, insects or injury.

Process beans are graded according to federal standards and standards set by individual processors. Contact processors for grade requirements of beans.

BEETS

Varieties

Fresh market: Ruby Queen, Vermilion (round); Formanova (cylindrical).

Process market: as required by processor.

Seed treatment

Purchase treated seed or treat seed with **Captan or Thiram**.

Seeding and spacing

Seed when soil temperature is over 4°C. Optimum range for germination is 10-24°C. Sow bunch beets at bi-weekly intervals. Plant 1-2 cm (0.5-.75 in.) deep. Space rows 30-40 cm (12-16 in.) apart and set seeder to give a final in-row spacing of 5-8 cm (2-3 in.). Double line seed rows should be planted if a belt-type seeder is used. Between-row spacing must be adequate to allow for a mechanical harvester if one is to be used.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Broadcast and work in 70 to 90 kg/ac (170 to 225 kg/ha) of 11-55-0 and 90 kg/ac (225 kg/ha) of 34-0-0 or the equivalent.

Side dress with about 10 to 15 kg/ac (30 to 35 kg/ha) of nitrogen during the growing season. Apply 35 to 45 kg/ac (90 to 110 kg/ha) of 34-0-0.

Weed control

Ro-Neet (720 g/L cycloate) at 2.0 to 2.5 L/ac (4.75 to 6.25 L/ha) for control of annual grasses, black nightshade, henbit, hairy nightshade, lamb's-quarters, purslane and redroot pigweed. Immediate soil incorporation is essential. Ro-Neet does not control weeds of the mustard family. Ro-Neet should be applied in 80 to 160 L/ac (200 to 400 L/ha) of water.

Pyramin (470 g/L parazon). Apply at 3.3 to 4.0 L/ac (8.25 to 10.25 L/ha) as a preplant incorporated treatment in a band. Apply in 40 to 100 L/ac (100 to 250 L/ha) of water. Pyramin controls black nightshade, wild buckwheat, chickweed, knotweed, smartweeds, lamb's-quarters, mustard, oakleaved goosefoot, pigweed (prostrate, redroot), purslane, ragweed, shepherd's-purse, stinkweed and yellow rocket. Check label for instructions for fall ridging.

Do not seet red beets in land where **Treflan, Triflurex** or **Rival** was applied in the previous year.

Disease control

Damping-off, black leg

Sow into a firm, moist seedbed. Treat seed with Captan, Thiram, Dexon or Dexon + Terrachlor dusts. Follow manufacturer's directions.

Storage and handling

Beets intended for storage should be harvested when roots are mature. Damaged and misshapen roots should be discarded. A temperature of 4° to 5°C and a relative humidity about 95% should be maintained. Beets will store up to 4 or 5 months under these conditions.

Bunched beets are often harvested before they reach full maturity. They are not held for long periods in storage although they can be held for 10 to 14 days at 0°C and high relative humidity. Generally, bunched beets should be harvested as close to sale as possible.

Grade and packaging standards

The grades for beets are Canada No. 1 and Canada No. 2. Canada No. 1 beets have similar varietal characteristics, are not soft or shrivelled, are trimmed so that 75% of the tops do not exceed 1 cm

(0.5 in.) and the remainder are not longer than 2.5 cm (1 in.); are free from decay and defect and are reasonably clean. They must have a minimum diameter of 3.2 cm (1.25 in.) and a maximum diameter of 7.6 cm (3 in.). A minimum diameter of 2.5 cm (1 in.) is allowed if that size is clearly marked on a transparent package or the beets are in a bulk display. Canada No. 2 beets have less stringent size requirements. General tolerances exist for both grades.

Beets grown for processing are graded to standards set by individual processors and are usually identified in contracts.

Package sizes for table beets are 907 g (2 ib), 2.27 kg (5 lb) bags and 22.7 kg (50 lb) bags or cartons.

CABBAGE, CAULIFLOWER, BROCCOLI BRUSSELS SPROUTS (COLE CROPS)

Varieties

Cabbage:

Earliest - Early Marvel, Tucana, Early Greenball, Emerald Acre
Early - Headstart, Princess, Copenhagen Market Early, Gladiator, Market Prize.
Mid - Bonanza, Guardian, Blue Boy, Blue Crown, Prime Pack.
Late - Storage Green, Houston Evergreen.

Chinese Cabbage:

Summertime - Arcadia, China Pride, Green Rocket, Nagaoka 60.

Red:

Early - Ruby Ball, Red Debut, Meteor.
Late - Red Head, Storage Red

Savoy:

U-neek, Chieftan.

Sauerkraut:

Jumbo, King Cole, Canada Kraut.

Cauliflower:

Early - White Emperor, White Summer.
Late - White Rock, White Fox, Self Blanche, Andes.

Broccoli:

Mercedes, Green Comet, Premium Crop, Green Valiant, Cruiser.

Brussels Sprouts:

Prince Marvel, Jade Cross E.

Seed treatment

Cole crop seed must be hot water treated to prevent blackleg and black rot and should be purchased as such. If hot water treated seed is not available, follow hot water treatment recommendations on page 21. Seed should be treated with Captan or Thiram seed treatment.

Young seedlings grown for transplanting should be grown in fumigated soil or seedbeds. (See Asparagus - Crown rot.)

Seeding and planting

All cole crops except brussels sprouts and late cabbage can be direct seeded in the field in most areas of the province. Brussels sprouts require transplanting in all areas and late cabbage requires transplanting in central and northern regions in order to reach maturity before frost.

Cole crops transplant well and there are several advantages to starting plants early and transplanting into fields. The biggest advantage is early harvesting. Normally, transplanted plants are harvested 3-4 weeks earlier than those direct seeded in the field. Growers are assured of near perfect stands of uniform crops. The cole crops tend to be more uniform in shape, size and maturity. Good transplants also provide some degree of flea beetle control as they will withstand flea beetle attacks without being killed.

Cole crops are cool season plants and will germinate at relatively low temperatures (10°C). Emerged seedlings and well hardened transplants are frost tolerant. Normally, cole crops can be field seeded between April 25 and May 15, depending on location. Plants grown for transplants should be started about 4 weeks before field setting (approximately April 1-15). Brussels sprouts transplants require about 6 weeks.

Chinese cabbage is sensitive to extreme heat and should be planted early as transplants or seeded in late June. Transplants should mature prior to extreme summer heat and late seeded crops will mature in cooler fall temperatures.

Plant cole crops 1-2 cm (0.5-0.75 in.) deep. 110-140 g of seed will provide enough cole crop transplants for 1 ac (280-350 g/ha). 0.8 kg/ac (2.2 kg/ha) will be required for direct seeding. About 0.2 kg/ac (0.5 kg/ha) of seed will be required if a precision seeder is used.

More detailed information on production of cole crops is available in a factsheet titled *Commercial Cole Crop Production*, FS 252/20-1.

Spacing

Early Cabbage -	Rows	60-75 cm (24-30 in.) apart
	Plants	25-35 cm (10-14 in.) apart
Late cabbage and brussels sprouts -		
	Rows	60-90 cm

		(24-36 in.) apart
	Plants	40-50 cm (16-20 in.) apart
Cauliflower -	Rows	60-90 cm (24-36 in.) apart
	Plants	30-45 cm (12-18 in.) apart
Broccoli -	Rows	45-75 cm (18-30 in.) apart
	Plants	30-45 cm (12-18 in.) apart
Chinese cabbage -	Rows	60-75 cm (24-30 in.) apart
	Plants	30-45 cm (12-18 in.) apart.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting, broadcast and work in up to 70 kg/ac (180 kg/ha) of 11-55-0 and 45 kg/ac (110 kg/ha) of 34-0-0 or the equivalent.

Apply an additional 14 to 16 kg/ac (35-40 kg/ha) of nitrogen as a side-dress application or through the irrigation system about one month after seeding or planting. Apply 45 kg/ac (110 kg/ha) of 34-0-0.

If transplanting, apply 280 mL (4 fl oz) of the following solution to each plant: 4.5 kg (4 lb) of 10-52-10 (or equivalent) in 560 L (50 gal) of water.

Weed control

Members of the mustard family (e.g., stinkweed, shepherd's-purse) cannot be chemically controlled in cole crops and adequate crop rotation in previous years or cultivation in the growing season will be required to control these weeds.

Treflan 545 EC, **Triflurex 400 EC** or **Rival 500 EC** as a preplant incorporated treatment is registered for use in transplants of broccoli, brussels sprouts, cabbage and cauliflower and direct-seeded cabbage and cauliflower. The application rates, incorporation instructions, etc. are the same as those listed under beans.

Cole crops are particularly sensitive to residues of linuron (**Lorox, Afolan**) and **metribuzin (Sencor, Lexone)**. In situations where applications of any of these products occurred late the previous season, growers should rotate to some other crops than cole crops.

Insect control

Because of the waxy leaves, use a spreader-sticker with all insecticide sprays on cole crops.

Aphids

Powdery, greenish-grey species on leaf undersides or on stems. Check plants frequently and alternate between chemical groups to help prevent resistance build-up. Apply one of the following sprays:

- Early season, 2-3 weeks control.

Cygon 4E, (Lagon, System) 48 EC at 225 to 400 mL/ac (550 to 1000 mL/ha) (broccoli, cabbage, cauliflower - 4 days, brussels sprouts - 21 days) - Repeat as necessary, or

Systox 24 EC at 0.90 L/ac (2.25 L/ha) (21 days).

Alternative chemicals and formulations: **Systox 72 EC** (21 days); **Di-Syston 15G, 72 EC** (30-42 days); **Metasystox-R 24 EC** (21-24 days).

- Mid season, 7-10 days control.

Monitor 480 48 SN at 445 to 930 mL/ac (1.1 to 2.3 L/ha) (cabbage, cauliflower - 7 days, broccoli, brussels sprouts - 14 days). Repeat at 7 day intervals, or

Thiodan (Endosulfan) 4E 40 EC at 565 to 850 mL/ac (1.4 to 2.0 L/ha) (7 days). Apply at temperatures over 22°C.

Alternative chemicals and formulations: **Thiodan 50 WP** (7 days); **Diazinon 50 WP, 50 EC** (5-14 days); **Guthion 50 WP, 12 EC, 24 EC** (7-21 days).

- Late season, less than 1 weeks' control.

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (broccoli, cabbage - 2 days, brussels sprouts, culiflower - 3 days), or

Malathion 50 EC at 0.5 to 1.0 L/ac (1.25 to 2.5 L/ha) (broccoli - 3 days, cabbage, cauliflower, brussels sprouts - 7 days). Use at temperatures above 21°C.

Alternative chemicals and formulations: **Malathion 85 EC, 4 DU** (3-7 days); **Dibrom 86.4 EC** (4 days); **Rotenone 1 DU** (1 day).

Cabbageworm, cabbage looper, diamondback Moth

Green caterpillars either large and velvety-green or small and wriggling. Feed on undersides of leaves producing holes. Check plants frequently and treat when damage first observed or soon after white butterflies or diamondback moths are observed in the crop. Alternate between chemical groups to help prevent resistance buildup.

Apply one of the following foliar sprays:

Monitor 48 SN at 445 to 930 mL/ac (1.1 to 2.3 L/ha) (cabbage, cauliflower - 7 days, broccoli, brussels sprouts - 14 days) - Repeat at 7 day intervals, or

Lannate L, (Nudrin) 21.6 SN at 445 to 910 mL/ac (1.1 to 2.25 L/ha) (Cabbage - 1 day, broccoli, brussels sprouts, cauliflower - 7 days), or

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (broccoli, cabbage - 2 days, brussels sprouts, cauliflower - 3 days). In subsequent applications use half the rate, or

Thiodan 4E, 40 EC at 565 to 850 mL/ac (1.4 to 2.1 L/ha) (7 days) - Apply at temperatures over 22°C, or

Belmark 30 EC at 60 to 130 mL/ac in 140 to 220 L water/ac (150 to 325 mL/ha in 350 to 550 L water/ha) (14 days). Do not use a wetting agent when applying Belmark to cabbage, or

Decis 5 EC at 60 to 80 mL/ac in 140 to 220 L water/ac (150 to 200 mL/ha in 350 to 550 L water/ha), (7 days), or

Ambush 50 EC at 30 to 60 mL/ac in 160 to 270 L water/ac (70 to 140 mL/ha in 400 to 675 L water/ha) (cabbage, cauliflower, brussels sprouts - 3 days, broccoli - 7 days), or

Dipel at 45 to 110 g/ac (110 to 275 g/ha). No time restrictions. Use 220 to 445 g/ac (550 to 1100 g/ha) for cabbage looper. Apply when caterpillars are small. Allow 3 to 4 days for mortality to occur.

Use **Belmark, Ambush** and **Decis** at cooler temperatures and for larger caterpillars.

Alternative chemicals and formulations: **Pounce 38.4 EC** (3-7 days); **Sevin 50 WP, 80 WP, 43 SU** (3 days); **Guthion 50 WP, 12 EC, 24 EC** (7-21 days); **Malathion 4 DU, 50 EC, 85 EC** (3-7 days); **Methoxychlor 50 EC** (3-14 days); **Dylox 80 SP, 42 EC,** (21 days); **Dibrom 86.4** (4 days); **Rotenone 1 DU** (1 day).

Cutworms

Usually red-backed cutworms which cut off young plant at base.

Apply one of the following:

Lorsban 4 E, 48 EC at 970 mL in 80 to 160 L of water/ac (2.4 L in 200 to 400 L of water/ha) (P). Apply once to soil 3-7 days before planting or transplanting. Do not incorporate, or

Lorsban 25 WP at 0.9 to 1.8 kg/ac in 80 to 160 L of water) (2.25 to 4.5 kg/ha in 200 to 400 L water) (32 days). Apply at 2 to 5 leaf seedling stage only.

Flea beetles

Small black or black and yellow jumping beetles attack seedlings at pre-emergence and post-emergence stage, chewing notches in stems and shotholes in cotyledons and leaves. Early protection is essential for cole crops in most areas of Alberta, particularly in precision seeded crops.

Apply one of the following as a foliage spray and repeat as necessary at one or two week intervals as necessary until plants are well established.

Thiodan 4E, 40EC at 565 to 850 mL/ac (1.4 to 2.1 L/ha) (7 days). Apply at temperatures over 22°C or

Sevin 50 WP at 445 to 930 g/ac (1.1 to 2.3 kg/ha) (3 days).

Alternative chemicals and formulations: **Sevin 80 WP, 43 SU** (3 days); **Di-Syston 15 G, 72 EC** (30-42 days); **Methoxychlor 50 EC** (3-14 days); **Rotenone 1 DU** (1 day); **Ambush 50 EC** (3-7 days).

In 1985 trials in the Edmonton area, **Dasanit 15 G**, registered for root maggot control, gave good protection of seedlings from flea beetles.

Thrips

Tiny, various colored insects which sometime become a problem after cabbage head formation. They feed under wrapper leaves, rasping tissue to leave oedema-like symptoms. Worse in hot, dry weather.

Apply one of the following as a foliar spray as soon as heads begin to form and repeat at weekly intervals as necessary.

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (broccoli, cabbage - 2 days, brussel sprouts, cauliflower - 3 days or

Rotenone 5 WP or 5 DU at 4 to 5 kg/1000 L (4 to 5 lb/100 gal) of water (1 day).

Cygon and **Decis**, registered on cole crops for other pests, have given some protection also.

Root maggots

Gray-black flies lay eggs at the base of the plant from late May to late June. Plants as young as 2 to 3 leaf stage may be attacked. A second generation emerging in mid to late July may lay eggs in the heads of some types of cole crops. A single early season treatment is normally adequate to protect roots of cole crops from significant damage.

Apply one of the following materials:

Pre-seeding and pre-transplanting:

Dasanit 15 G at no more than 7.6 kg/ac (18.75 kg/ha) or 125 g/100 m (1.5 oz/100 ft) of row (40 days). Apply in a 15 cm (6 in.) band prior to seeding or transplanting. Cultivate into top 2.5 cm (1 in.) of soil. Make a second application 14 days later using Dasanit 72 EC (see below) or

Diazinon 5 G at 150 g/100 m (1.6 oz/100 ft) of row. Apply in furrow at seeding.

Post-seeding or post-transplanting:

Dasanit 72 EC at 25 mL in 10 L water/100 m of row (1 fl. oz. in 20 pint of water/100 yd of row) to a maximum of 1.7 L/ac (4.25 L/ha) (40 days). Drench within 3 days of transplanting or 7 to 10 days after seeding (if granular treatment was applied) or

Lorsban 4 E at 1.4 L/ac (3.5 L/ha) in 400 L/ac

(1000 L/ha) water at 1.4 L/ac (3.5 L/ha) for 60 cm row spacing and 2.8 L/ac (8 L/ha) for 30 cm row spacing. Apply 10 cm on either side of the plant 7-10 days after seeding or 3 days after transplanting (chinese cabbage, broccoli, cabbage, cauliflower, brussels sprouts - 32 days or

Lorsban 25 WP at 1.25 to 1.3 kg/ac (3.1 to 3.25 kg/ha) (32 days). Use only on cabbage as a transplant treatment at 200 mL solution per plant or

Diazinon 5 G at 80 g/10 m (1 oz/10 ft) of row within a 10 cm (4 in.) radius of each plant or

Guthion 50 WP at 1 kg/1000 L (1 lb/100 gal). Apply at 160 ml (7 fl oz) per plant at or immediately after transplanting. (brussels sprouts - 7 days, broccoli, cauliflower - 15 days, cabbage - 21 days).

Alternative chemicals and formulations:

Guthion 24 EC. In 1986 trials in the Edmonton area, **Lorsban** and **Dasanit 15 G and 72 EC** gave poor root maggot control while Lorsban 4E gave good control.

Disease control

Black leg

Use clean seed or hot water treated seed (see the section on SEED TREATMENT). Eradicate cruciferous weeds. Use a four year crop rotation with noncruciferous crops. Maintain good soil drainage.

Black rot

Use clean seed or seed soaked in hot water (see section on SEED TREATMENT). Use a two-year rotation without crucifers in the production fields. Use a three-year rotation on transplant beds. This latter practice is important as spread of disease occurs mostly in the seedbed. Check seed catalogues for reference to disease resistance.

Sclerotinia rot (drop or watery soft rot)

Rotate with resistant crops such as grasses, cereals, beets, onions, spinach or corn. Plant in well-drained soil. Use a plant spacing which will allow good air circulation among plants. Practise good field sanitation (remove and destroy diseased plants). Disinfect storage bins prior to harvest using steam, copper sulphate at 1 kg/50 L (2 lb/10 gal) of water, or formaldehyde 37% SN 2.5 L/100 L (2.5 gal/100 gal) of water. Storage areas must be allowed to aerate until odor is gone before storing produce.

Soft rot

Avoid injuring plants as much as possible during cultivation and harvesting. Use plant and row spacings which will allow for good air circulation. Avoid, warm humid storage conditions. Prolonged overhead irrigation may increase infection. Control root maggots, slugs and chewing insects. Avoid excess nitrogen. Minimize frost injury. Disinfect storages (see SCLEROTINIA ROT).

Wirestem, damping-off

Delay planting as long as possible to avoid cold, moist soils which favor disease development. Avoid excessive irrigation. Grow transplants in fumigated seedbeds (see ASPARAGUS-CROWN ROT). Space seedlings in seedbeds to allow air circulation around plants. Dust seed with Captan or Thiram prior to planting.

Special problems

Cauliflower blanching

It is imperative to market only white compact heads of cauliflower. Heads that develop during hot weather and are exposed to sunlight become yellow and unmarketable. There are three methods that can be used to help reduce yellowing.

Use recommended varieties. A criterion used in selecting cauliflower varieties is the ability of the plants to protect the heads with leaves and produce a white curd.

Tying heads. When the head is small it is well covered by leaves. As the head expands the covering leaves are pulled away and the head becomes exposed. The large outside leaves of the plants can be tied over the small head. Since plants will be ready for tying at different times, use differenct colored string on each day. A few plants of one color string can be checked and if mature the entire lot can be harvested without checking each plant. Head tying works very well, however, it is not practical on large plantings as it is very labor intensive.

Breaking two or three of the larger inside leaves over the head is quicker than tying, however, it is not generally satisfactory.

Crowding plants. An alternative method of helping to produce white curds is to reduce the between-row and in-row spacings. By planting cauliflower in rows of 60 cm (24 in.) apart and spacing plants 25-30 cm (10-12 in.) apart in the row, the outside leaves will tend to grow in a more upright position. This more intensive upright leaf growth shades the developing curds more than if the plants are farther apart, however, crowding can delay maturity, reduce head size, and may promote disease. This method is recommended on a trial basis.

Brussels sprouts development

Only a few varieties are recommended for Alberta because they require a relatively long growing season. Because of Alberta's short growing season, even recommended varieties will not produce well in some years. The development of sprouts can be improved by pinching the growing point of the plants when the middle sprouts are about 1-2 cm (0.5-.75 in.) in diameter (early August). This also improves uniformity and promotes maturity which is desirable for a single harvest.

Cabbage splitting

Cabbage splitting can be largely overcome by using recommended varieties and maintaining uniform soil moisture. However, knowing when the crop is mature and harvesting it at that time is the best prevention. Varieties are selected, in part, for their lack of splitting at maturity, and for the length of time they will remain whole after reaching maturity. Splitting may result from rain or irrigating a dry soil close to the maturity date. This causes rapid growth after a period of slow growth, and results in splitting. One method of partially controlling splitting is by deep cultivation to prune roots and reduce water uptake. This method is difficult and may result in some mechanical damage if not done carefully. Proper irrigation should prevent most splitting. Uneven maturity resulting from uneven germination and growth--uneven or poor irrigation, insect and mechanical damage--will increase the risk of splitting if the crop cannot be continually harvested as the plants mature.

Since splitting can be overcome by harvesting when the crop is mature, knowing when to plant the crop can also be important. For example, it would not be wise to field set transplants of a storage variety on April 15. The variety would probably mature before common storages are cool enough. Plant early, mid-season and late varieties in that order.

Cabbage maturity

Maturity of cabbage is determined by the firmness and density of the heads and by the size characteristic of that variety. Late storage cabbages should be hard and dense, but the outer head leaves should not be cracking nor the head starting to split. Heads of early and mid-season varieties of green cabbage and savoy cabbage are firm at maturity but do yield to moderate pressure when squeezed.

Cauliflower and broccoli maturity

The maturity of cauliflower and broccoli should also be determined by the firmness and compactness of the heads--not so much by their size. Heads of both should be full, firm and compact. Cauliflower heads should be deep.

Heads must be harvested when they reach this stage. Both broccoli and cauliflower heads become unmarketable very quickly. Hot weather hastens over maturity. Broccoli florets become loose, stalks elongate and flowers start to develop. Cauliflower curds separate, become uneven and 'ricey'.

Storage and handling

Cole crops should generally be stored at 0°C and more than 95% relative humidity. Only mature, disease-free specimens should be stored.

Broccoli has a storage life of approximately 1 week. Storage life can be increased by using nonperforated poly bags.

Brussels sprouts have a storage life of 3 to 4 weeks at 0°C and a high relative humidity; sprouts will also benefit from storage in poly bags.

Cauliflower is not usually stored; it can, however, be held for up to 2 weeks at 0°C.

Early cabbage generally is not stored; if necessary it can be held for 3 to 4 weeks.

Late cabbage can be successfully stored for 5 to 6 months at 0°C and high humidities. Cabbage may be stored in bulk or in tote bins. Depth of bulk stored cabbage should not exceed 2-3 m (6-8 ft). Adequate ventilation is required. Varieties vary considerably in their ability to retain a green color. (See variety recommendations.)

Grade and packaging standards

The following is a guide and has no official sanction.

Cabbage

Grade classes for cabbage are Canada No. 1 and Canada No. 2. Canada No. 1 grade cabbage has similar varietal characteristics, has heads that yield only slightly to pressure, except the savoy type which must have heads that are not soft; are trimmed so that butts are not longer than 1.2 cm (0.5 in.) with all outer leaves injured by insects, disease or mechanically removed and have no more than 6 wrapper leaves per head; are free from heads that are split or show the formation of the seed stalk; are free from decay; are free from injury or defect that materially affects the appearance, edibility or shipping quality; that do not vary more than 5 cm (2 in.) in diameter when packaged.

Canada No. 2 cabbage is similar to Canada No. 1 except that the injury and defect tolerance is increased to 15% of the edible portion of the head.

General tolerances allow that 10% of packages may contain heads that exceed the permitted size variation; 2% of the heads by count may be affected by decay; 5% of the heads by count may have the same grade defect; 10% of the heads by count (including the 2 and 5% previously indicated) may have grade defects and still meet the grade standards for Canada No. 1 and No. 2 cabbage.

The package sizes for cabbage are: 18 kg (40 lb) and 22.7 kg (50 lb) bags or cartons.

Cauliflower

Grades for cauliflower are Canada No. 1 and Canada No. 2. Canada No. 1 cauliflower has compact heads, is fresh with green wrapper leaves; has heads free from abnormal color or riciness; are free from damage and decay; have a minimum head diameter of 10 cm (4 in.), which do not vary more than 5 cm (2 in.) when packaged. Canada No. 2 cauliflower has similar requirements except that there are no size minimums. A series of general tolerances also affect each grade.

There are no official package sizes for cauliflower.

Broccoli

There are no grade standards for broccoli and any designations should be agreed to by the seller and buyer. However, a grower should sell only top quality broccoli; fresh and not wilted; firm and compact heads with no evidence of flowers beginning to open; heads that do not have leaves growing up through the centers; outside leaves removed from the stem; single heads 10-15 cm (4-6 in.) with 15-20 cm (6-8 in.) stem; bunches in 12-15 cm (5-6 in.) bundles with 15 cm (6 in.) stems; uniform bunches not varying more than 5 cm (2 in.). There are no official package sizes for broccoli.

Brussels sprouts

Generally Canada No. 1 brussels sprouts have sprouts removed from stalk; are not wilted or split and are firm; are green in color (not yellow and discolored); have a minimum diameter of 2 cm (1 in.) and maximum diameter of 5 cm (2 in.); have maximum length of 7 cm (2.75 in.); are free from decay, injury and defects which affect appearance, edibility and shipping quality. Canada No. 2 brussels sprouts have no maximum diameter limits. The package sizes for brussels sprouts are 283 g (10 oz) and 454 g (16 oz) bags or cups.

CARROTS

Varieties

Fresh market:
Nantes-Frantes, Lindoro, Nangro, Special Nantes 616.
Imperator - Imperator 58, Gold Pak 28, Gold Pak 263, Spartan Fancy, Hicolor.
Baby carrots: (for bunching, fresh pack or processing) Baby Finger Nantes, Amstel, Touchon Deluxe, Vita Sweet 500, Camden, Narante.
Process market: (dicing) As required by processor or Royal Chantenay, Red Cored Chantenay, Chantenay Supreme Long Type.

Seed treatment

Buy seed or treat with Captan or Thiram as directed by manufacturer.

Soils

Carrots should be grown on a loose, friable, sandy loam soil if possible. However, it is possible to grow carrots on heavier soil if the proper cultural practices are followed. All soil should be well drained.

Because of the rooting habits of this crop and the desirability of producing a high percentage of long, straight smooth roots, the soil should be worked to a minimum depth of 30 cm (12 in.). This allows for unobstructed root extension and development, easy moisture penetration and adequate aeration of the soil. A uniform, well worked seedbed should be prepared before seeding commences.

Seeding

Carrots should not be planted into cold soil as they do not germinate well below 10°C. In the southern regions, carrots are not normally seeded before April 20. Most crops are seeded between May 1 and May 15. In northern areas seeding may be delayed until late May.

When seeding is delayed because of weather, the seeding rates may have to be reduced to allow for roots to develop to marketable size before severe frosts kill the tops.

Carrots are shallow seeded 1-2 cm (0.5-0.75 in.). Germination can be hindered or the crop killed if the soil around the seed dries out. Irrigation in southern areas is normally essential to establish a good stand of carrots. Seeding may have to be delayed until irrigation water is available.

Following are seeding recommendations for fresh market carrots. Growers are recommended to use a belt type seeder equipped with 7 cm (3 in.) triple-line shoes. Belts are punched with three rows of holes. Hole number and size depend on seeding rate required and on the size and shape of the carrot seeds. Carrot seed varies greatly in size, normally ranging from 330,000 to 880,000 seeds/kg (150,000 to 400,000 seeds/lb). Depending on seed size and stand required a grower can expect to use from 0.8 to 3.0 kg/ac (2 to 7 kg/ha) of seed. Normal requirements are about 1.2 to 2.0 kg/ac (3 to 4.5 kg/ha).

Long type carrots grown for storage should be planted to achieve a final stand of about 100 plants/m (30 plants/ft) in a triple-line band 7 cm (3 in.) wide. The centre line of the seed belt should have about 30-50% fewer holes than the outside lines. Long type carrots or Nantes types grown for early bunching or early cellopak trade should be planted to achieve a final stand of 60-100 plants/m (20-30 plants/ft).

Carrots are difficult to germinate on coarse textured mineral soils. Both field conditions (field factor) and percent germination can greatly reduce the number of seeds planted that will emerge. A normal range for emergence is 40-60%. This means that for every 100 seeds planted about 40-60 carrot plants will become established. As a rule of thumb, use 50% as a guide.

More detailed information on production of carrots is available in a factsheet titled *Commercial Carrot Production in Alberta* FS 258/20-2.

Row spacing

Row spacing must be compatible with harvest equipment used. Although the mechanical harvester can be adapted to harvest rows as close as 30 cm (12 in.) apart, growers find it difficult to harvest most varieties spaced less than 45 cm (18 in.) apart because the tops between rows tend to bind together. This problem is increased as heavy frosts weaken and drop the tops.

Normally cellopak carrots are grown on single-row beds spaced 60 cm (24 in.) on centre. Alternatives include: 3 or 4 rows on beds with 1.8 m (6 ft) centres; or growing two rows on beds with 90 cm (3 ft) centres. Single-row beds 60 cm (24 in.) on centre have 50 cm (20 in.) wide tops and are 15-20 cm (6 to 8 in.) high.

Fertilizer

Growers should always base fertilizer applications on the result of annual soil tests.

Prior to planting, broadcast and work in 90 to 100 kg/ac (225 to 250 kg/ha) of 11-55-0 and 90 kg/ac (225 kg/ha) 34-0-0 or the equivalent.

Broadcast about 15 kg/ac (35 kg/ha) of nitrogen or put about the same amount of nitrogen through the irrigation system during the growing season.

The phosphorus fertilizer may be banded into the seedbed prior to planting.

Weed control

Treflan, Triflurex or **Rival** application instructions are the same as for beans, page 58.

Preemergence

Afolan F (450 g/L), Lorox L (480 g/L) linuron controls a variety of broadleafed weeds (Table 7, p. 32). For preemergence (crop) applications, rain or irrigation is required for good control. Apply **Afolan F** at 0.56 to 1.1 L/ac (1.4 to 2.7 L/ha) or Lorox L at 0.44 to 1.3 L/ac (1.1 to 3.4 L/ha).

Postemergence

Apply **Afolan F** at 0.8 to 2.0 L/ac (1.9 to 5 L/ha) or Lorox L at 0.9 to 1.8 L/ac (2.25 to 4.5 L/ha) in 80 to 120 L/ac (200 to 300 L/ha) water.

Do not apply with greater than 275 kPa (40 psi) pressure. Spray when carrots have two or more fully developed leaves. Use lower rates on small seedling weeds and higher rates on larger established weeds. Apply before annual grasses exceed 5 cm (2 in.) in height or before broadleaf weeds exceed 15 cm (6 in.). During hot dry weather, spray in the cool part of the day to avoid injury.

For a combination of preemergence and postemergence applications, consultthe herbicide label.

Herbicidal Oil (**Shell AWK No. 1**, Varsol and others). Controls annual grasses, redroot pigweed, lamb's-quarters and purslane in the seedling stage. Apply 240 to 325 L/ac (600 to 800 L/ha) as an overall treatment after carrots have developed first true leaves and before roots are thicker than a pencil.

Hoe Grass 284. Application instructions are the same as for Beans, page 58.

Insect control

Leafhoppers

The main concern is the aster leafhopper, a small pale yellow leafhopper with black dots and dashes on the head. It transmits aster yellows disease to carrots. In areas where this is a problem (mostly southern Alberta) isolate plantings from forage legume fields, cereal crops and very weedy areas where leafhoppers breed, and rogue infected plants. If necessary apply one of the following as a foliar spray:

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (3 days), or

Sevin 50 WP at 445 to 930 g/ac (1.1 to 2.3 kg/ha) (1 day), or

Methoxychlor 50 WP at 0.7 to 2.0 kg/1000 L water/ac (1.7 to 5 kg/1000 L water/ha) (7 days).

Alternative chemicals and formulations: **Sevin 80 WP, 48 SU, 43 SU** (1 day); **Methoxychlor 24 EC** (7 days).

Disease control

Aster yellows

Isolate carrot plantings from forage legume fields and rough weedy areas where leafhoppers may abound. Remove infected plants as soon as detected, if practical. Control leafhoppers in fields and perimeter areas (see INSECT CONTROL).

Leaf blight and leaf spot

Rotate to an unrelated crop for few years. Practise good field sanitation. Apply **Bravo 500** at 0.9 to 1.3 L/ac (2.4 to 3.2 L/ha) (1 day), **Dithane M-45** or **Manzate 200** at 0.9 kg/ac (2.25 kg/ha) (7 days) or **Zineb 80 WP** at 1.3 kg/ac (3.2 kg/ha) (7 days) at the first signs of infection and repeat every 7-14 days as necessary. Work in crop refuse after harvest to hasten breakdown of foliage.

Rubbery root

Provide adequate drainage in the field. Harvest as soon as the carrots are mature. Storages should be well ventilated and disinfected between crops (see COLE CROPS - SCLEROTINIA ROT). Rotate with cereals or grasses.

Soft rot

Harvest and handle the crop carefully to avoid bruising. Cull rotted roots before storage. Allow roots to dry before storing. Store under cool (0-1°C), humid (90-95% RH) conditions with adequate aeration. Disinfect storages between crops (see COLE CROPS - SCLEROTINIA ROT).

Sclerotinia rot (white mold)

Rotate with resistant crops such as grasses, cereals, beets, onions, spinach or corn. Plant in well-drained soil. Use a plant spacing which will allow good air circulation among plants. Practise good field sanitation (remove and destroy diseased plants). Disinfect storage bins prior to harvest. (See COLE CROPS - SCLEROTINIA ROT). To control the disease in storage, spray or dip washed or unwashed carrots, either before or during the storage period with Benlate 50 WP at 0.5-1.0 kg/1000 L (1.2-2.0 lb/500 gal) of water.

Storage and handling

Mature topped carrots store well for 5 to 6 months when held at 0°C and more than 95% relative humidity.

Quick removal of field heat will lengthen the storage period.

Bacterial soft rot and white mold can cause serious losses in storage. (See disease control)

Grade and packaging standards

The following is a guide and no official sanction.

The grades for carrots are Canada No. 1, Canada No. 1 - cut crowns and Canada No. 2.

Canada No. 1 carrots have similar varietal characteristics; are not woody, soft or shrivelled; are trimmed so that 75% of the tops do not exceed 1.2 cm (0.5 in.) and the remainder do not have tops more than 2.5 cm (1.0 in.); are not rough or misshapen; are clean; are free from sunburn that extends more than 1.2 cm (0.5 in.) below the crown or affects more than 10% of the carrots in the lot; are free from decay and damage; are free from injury and defect that affects appearance, edibility or shipping quality or that cannot remain without the loss of more than 5% of total weight; have a minimum length of 11 cm (4.5 in.) and have a minimum and maximum diameter as marked on a package, however, the minimum diameter cannot be less than 2 cm (0.75 in.). Freedom from damage is specifically defined for this grade; crown damage cannot exceed 1.2 cm (0.5 in.) in depth, be discolored or exceed two-thirds the diameter of the carrot; broken carrots must be 15 cm (6 in.) in length and have a tip diameter greater than one-half the diameter of the carrot; fresh cracks must be clean, not over 3.3 mm (0.125 in.) wide, not over 6.3 mm (0.25 in.) long or exceed one-third the length of the carrots.

Canada No. 1 - cut crowns are carrots that have crowns or shoulders removed but in every other way meet the requirements of the Canada No. 1 grade.

Canada No. 2 carrots are similar in grade requirements to Canada No. 1 except that injuries and defects are allowed up to 10% of the total weight.

The word "washed" can be used in connection with any of the grades provided the carrots have been washed prior to packaging.

The following general tolerances are applicable to all carrot grades; 4% of carrots by weight may be below the prescribed or designated minimum size; 8% by weight may exceed the maximum size; 2% by weight may be affected by decay; 5% by weight may have the same grade defectif this defect does not relate to over or under size; 10% of the carrots by weight may have grade defects including those previously listed and still meet grade standards.

The packaging standards for carrots are 907 g (2 lb), 1.36 kg (3 lb), 2.27 kg (5 lb), consumer sized packages and 11.3 kg (25 lb), 22.7 kg (50 lb) and 34 kg (75 lb) bags for bulk shipping. Master containers for consumer packages are not identified.

CELERY

Varieties

Green Giant, Improved Utah 52-70, Surepak, Tendercrisp, Ventura.

Seed treatment

Use hot-water treated seed. Buy treated seed or treat seed with 75% Thiram following manufacturer's recommendations.

Seeding and planting

Sow seed in the greenhouse about 10 weeks before transplanting into the field. Transplant to the field when there is no risk of prolonged temperatures below 13°C, as low temperatures induce bolting. Harden plants by the use of water withdrawal, not by the use of cold temperature. 225 g seed should grow enough transplants for one acre (560 g/ha). Until plants emerge, a temperature in the greenhouse of 21-24°C is suitable. The 18-24°C is ample for steady growth. Do not drop night temperatures below 13°C.

If plants are too tall at time of transplanting, they can be clipped back to 12-15 cm (5-6 in.); this may result in checked growth.

Spacing

The use of transplant machines limits the plant spacing used. Space plants 15-20 cm (6-8 in.) apart within rows that are 60-90 cm (24-36 in.) apart.

If celery is planted by hand, reduce between-row spacing to 45 cm (18 in.).

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting, broadcast and work in up to 100 kg/ac (250 kg/ha) of 11-55-0 and 55 kg/ac (140 kg/ha) of 34-0-0, or the equivalent.

Four to six weeks after planting, apply 10 to 15 kg/ac (30 to 35 kg/ha) of nitrogen as a sidedressing application. The nitrogen can also be applied through the irrigation system. Do not allow granular fertilizer to become lodged in the stems and leaves of the celery plants as burning can result.

Weed control

Afolan F (450 g/L). Apply 0.7 to 2.0 L/ac (1.9 to 5.0 L/ha) in 80 to 120 L/ac (200 to 300 L/ha) water after celery transplants are established, but early postemergence to weeds. Some temporary discoloration of the crop may occur.

Herbicidal oils 240 to 325 L/ac (600 to 800 L/ha) before hearts form or before plants are over 15 cm (6 in.) tall and when weeds are small.

Insect control

Aphids

Small green species clustered on leaves and stalks and in crowns. Spray into crowns at not less that 690 kPa (100 psi) pressure.

Apply one of the following as a foliar spray:

Malathion 50 EC at 810 mL/ac (2.0 L/ha) (7 days), or

Dibrom 86.4 EC at 445 to 670 mL/ac (1.1 to 1.65 L/ha) (4 days), or

Thiodan 4E, 40 EC at 850 mL/ac (2.1 L/ha) (14 days).

Alternative chemicals and formulations: **Malathion 25 WP**, 85 EC (7 days); **Dibrom** (Bromex) 65.4 EC; **Thiodan 50 WP** (14 days); **Phosdrin 60** SN (3 days); **Systox 24 EC**, 72 EC (28 days).

Disease control

Aster yellows

See CARROTS - ASTER YELLOWS.

Black heart

Maintain uniform moisture. Avoid heavy applications of high salt index fertilizers. Apply calcium nitrate (20% Ca) at 1 to 2 kg/100 L (10 to 20 lb/100 gal) of water or calcium chloride (36% Ca) at 0.5 to 1.0 kg/100 L (5 to 10 lb/100 gal) every 7-10 days as a foliar application during warm, cloudy periods when the disease may occur.

Special problems

Celery plants must be provided with constantly uniform high levels of soil moisture. Regular irrigation in most areas is essential to produce celery that is tender and free from "stringiness". Refer to section four of this publication on irrigation requirements of celery.

Storage and handling

Celery should be stored at 0°C and more than 95% humidity.

When held at these conditions, a storage life up to 3 months can be expected although celery is extremely sensitive to moisture loss. Storage in perforated plastic bags is of value.

Hydrocooling or vacuum-cooling is recommended when celery is marketed from the field.

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for celery are Canada No. 1, Canada No. 1 Heart and Canada No. 2.

Generally Canada No. 1 celery is fresh; is trimmed to remove damaged, coarse or misshapen outside branches; is free from decay, heart rot and stalks that show the formation of seed stems; is free from damage; has stalks of a minimum length of 30 cm (12 in.), a minimum average midrib length of 18 cm (7 in.) and a minimum diameter of 6 cm (2.5 in.) if more than 24 stalks are packed in a package or a minimum diameter of 7 cm (3 in.) if 24 or less stalks are packed in a package; and has packaged stalks that do not vary more than 3 cm (1.5 in.) in diameter or 5 cm (2 in.) in length.

Canada No. 1 Heart possesses the same characteristics as Canada No. 1 except uniformity of size, minimum diameter and minimum stalk length.

Canada No. 2 celery is similar to Canada No. 1, with less specific size requirements except a minimum diameter of 6 cm (2.5 in.).

A series of general tolerances also affect each grade.

There are no official package sizes for celery.

SWEET CORN

Varieties

Fresh market early: (require between 1600 and 1800 Corn Heat Units to mature).
Yellow - Earlivee, Sunny Vee, Buttervee, Seneca Horizon.
White - Spring White.

Fresh market mid: (require between 1800 and 2000 Corn Heat Units).
Normal - Seneca Star, Early Sunray, Sprite, Earligem, Early Bird.
Super Sweet - Sugar Bun, Northern Super Sweet.

Fresh market late: (require between 2000 and 2200 Corn Heat Units). Normal - Sunburst Improved, Flavorvee, Calypso, Reliance, Harmony.
Super Sweet - Sugar Loaf, Summer Sweet.

Process market: as required by processor.

Seed treatment

Corn seed should be purchased treated with Captan to prevent seed rot during cool spring planting. An additional Diazinon-Lindane seed treatment should be used where necessary to prevent wireworm and seed maggot attacks.

Seeding and spacing

To ensure a continued supply of corn for the fresh market, growers should plant a number of varieties with different maturity dates.

Corn should be planted as early as possible but it does not germinate below 10°C. Emerged corn will withstand frost until it reaches about 10 cm (4 in.) in height because the growing tip is below the soil until that stage.

Corn should be planted into moisture, about 3-6 cm (1.5-2.5 in.) deep.

Seeding rates vary from 4 to 7 kg/ac (11 to 17 kg/ha) depending on seed size. Growers should try to establish stands of 50,000 plants/ha (20,000 to 22,000 plants/ac). Row spacing should be wide enough to allow for the mechanical harvester if one is used. Refer to Tables 3a and 3b, page 6 for in-row and between-row spacings which will give approximately 50,000 plants/ha (20,000 plants/ac).

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

If possible, nitrogen applications should be made before planting and again when corn is 30 cm (12 in.) high. When possible phosphorus should be put on before planting and at planting time.

Broadcast and work in prior to planting 45 to 70 kg/ac (110-170 kg/ha) of 11-55-0 and 35 kg/ac (85 kg/ha) of 34-0-0 or equivalent.

At planting time, band 25 to 45 kg/ac (55 to 110 kg/ha) of 11-55-0 five cm (2 in.) to the side and 5 cm (2 in.) below the seed.

When the crop is 30 cm (12 in.) high sidedress with 35 to 45 kg/ac (85-110 kg/ha) of 34-0-0 or add 10 to 15 kg/ac (30-40 kg/ha) of nitrogen through the irrigation system.

Weed control

Weeds in sweet corn may be controlled by two basic methods - cultural and chemical, or by a combination of both.

Cultural weed control - The continuous use of the same method of weed control or chemicals can lead to the buildup of weeds which are resistant or tolerant to the control method used. For example, in Ontario triazine resistant lamb's-quarters and pigweed have become a major problem because of repeated use of triazine herbicides in continuous corn cropping. Inter-row cultivation may be required when weeds escape herbicide treatments. Growers should therefore utilize as many options available as possible such as cultivation, crop rotation and usage of different chemicals.

Chemical weed control - Growers using atrazine in corn should replant the corn the following two years. The period of *atrazine* persistence which depends on the rate used, irrigation and climatic conditions may exceed two years. Beets are particularly sensitive to atrazine residues.

Herbicides for Use in Sweet Corn and Weeds Controlled.

		Annual Broadleaved																Annual Grasses.				Perennials			
Herbicide	**Method of Application**	Buckwheat wild	Chickweed	Corn Spurry	Flixweed	Groundsel common	Hempnettle	Henbit	Kochia	Lamb's quarters	Mustard wild	Nightshades	Pigweed redroot	Purslane common	Smartweeds	Stinkweed	Thistle Russian	Barnyard grass	Green foxtail	Wild oats	Volunteer cereals	Canada thistle	Field bindweed	Sow thistle	Quack grass
Atrazine/Aatrex	PPI	o				n			n	o	o	n	o	o	o	o		o		o	o				
Bladex	PPI/pre	o				n			o	o	o		o	o	o	o	o	o	o						
Atrazine +	PPI	n				n			n	o	o	n	o	o	o	o		o	o	o	o				
Primentra	PPI	n				n			n	o	o	n	o	o	o	o		o	o	o	o				
Atrazine + oil, Atra-Mix	Post	o				n			n	o	o	n	o	o	o	o			o	o					
Aatrex Plus	Post	o				n			n	o	o	n	o	o	o	o			o	o					
Bladex + oil	Post	o				n			o	o	o		o	o	o	o	o	o	o						
Dual	PPI																	o	o						
Eradicane	PPI		o	o				o		o	o		o	o				o	o	o	o				
Sutan +	PPI																	o	o						
2,4-D amine	Post				o					o	o					o	o					S	S	S	
Buctril M	Post	o			o	o	o			o	o		o		o	o	o					S		S	
Basagran	Post		o	o		o				o	o	o	o	o	o	o	o						S		
Laddok	Post		o	o		o				o	o	o	o	o	o	n									
Kil-Mor	Post	o		o	o					o	o		o		o	o	o					S	S	S	
Torch D5	Post	o				o				o	o		o		o	o	o								
Pardner	Post	o				o				o	o		o		o	o	o								

o = controlled, on label n = controlled, not on label S = suppresses growth

Registered Herbicides for Use in Sweet Corn

Herbicide and Active Ingredient	Rate	Type of Application	Remarks
Aatrex (500 g/L atrazine)	1.3 to 1.8 L/ac (3.2 to 4.4 L/ha)	PPI, Pre or Post	Postemergence application for control of foxtail should be applied when this weed is in the 1-2 leaf stage.
Aatrex Nine-0 (90% dispersible granules)	0.8 to 1.5 kg/ac (1.9 to 3.7 kg/ha)	PPI, Pre or Post	A recommended oil concentrate must be added for postemergence applications when none is present in the formulation. Atrazine is registered for tank mixes with Bladex, Dual, Eradicane and Sutan +. Apply in 60 to 120 L/ac of water. For PPI treatments, incorporate using a double dish or vibrating shank cultivator.
Aatrex Plus (400g/L atrazine + 25% oil concentrate)	1.7 L/ac (4.2 L/ha)	Post	
Atrazine F (500 g/L)	1.3 L to 1.8 L/ac (3.2 to 4.4 l/ha)	PPI, Pre or Post	
Atrazine 90W (90% wettable powder)	0.8 to 1 kg/ac (1.9 to 2.4 kg/ha)	PPI, Pre or Post	
Atra-Mix (400 g/L + 25% oil concentrate)	1.8 to 2.3 L/ac (4.4 to 5.6 L/ha)		
Primextra (atrazine 190 g/L + metolachlor 300 g/L)	2.6 to 3.4 L/ac (6.4 to 8.4 L/ha)	PPI	Broadcast and lightly harrow before planting (not more than 5 cm, 2 in. deep). Apply in 60-120 L/ac of water.
Dual (metolachlor 960 g/L)	0.8 to 1.1 L/ac (1.9 to 2.7 L/ha)	PPI	Incorporate to 5 cm. Controls certain grasses. Mix with atrazine, Bladex for broad-spectrum weed control.
Bladex Nine-T (90% dry flowable cyanazine)	0.9 to 1.1 kg/ac (2.2 to 2.7 kg/ha)	PPI, Pre or Post	Registered tank mixeswith Atrazine, Dual, Eradicane and Sutan +. For post-emergence applications, add 1 L Bio-Veg T.M. crop oil/100 mL spray solution. Do not apply beyond the 3-leaf stage of corn. Weak for redroot pigweed control.
Eradicane 8E (800 g/L EPTC + R25788)	1.7 to 2.2 L/ac (4.2 to 5.4 L/ha)	PPI	Can be tank mixed with atrazine, fluid fertilizers or impregnated on dry fertilizers. Apply in 40 L/ac water or more. Agitation in spray tank is required. Weed control may be reduced if Eradicane or Eptam have been used for two successive years or more. Incorporate into the soil immediately after spraying; check incorporation instructions as described in the bean section.

Herbicide and Active Ingredient	Rate	Type of Application	Remarks
Suntan + (butylate 800 g/L)	1.7 to 2.2 L/ac (4.2 to 5.4 L/ha)	PPI	Can be tank mixed with atrazine or Bladex. Sutan + can be impregnated on dry fertilizer or combined with fluid fertilizers and applied as a spray. Apply in 40-200 L/ac of water. Incorporate immediately.
2,4-D amine (500 g/L)	610 mL/ac (1.5 L/ha)	Post	Apply as an overall spray until corn is 15 cm high, use drop nozzles for taller corn. Water volume - 40 L/ac.
Buctril M (bromoxynil 280 g/L + MCPA 280g/L)	400 mL/ac (.98 L/ha)	Post	Can be tank mixed with atrazine but do not add oil concentrate. Apply when corn has 4-6 leaves. Use 80-120 L/ac water volume.
Basagran (480 g/L bentazon)	700 to 900 mL/ac (1.7 to 2.2 L/ha)	Post	Add 810 mL/ac Assist Oil concentrate. Apply 18-28 days after planting. Use 80-160 L/ac water volume.
Kil-Mor (2,4-D + mecoprop + dicamba)	340 to 450 mL/ac (.84 to 1.1 L/ha)	Post	Overall spray prior to 15 cm ht. of corn, use drop nozzles if crop is taller. Water volume 80-140 L/ac.
Laddok (bentazon + atrazine)	0.8 to 1.6 L/ac (1.9 to 3.9 L/ha)	Post	Apply 18-28 days after seeding. Corn tolerant at all growth stages. Assist Oil concentrate at 10 L/1000 L of spray solution is recommended. Water volume 80-160 L/ac.
Torch DS (450 g/L bromoxynil)	250 to 300 mL/ac (.62 to .74 L/ha)	Post	Apply when weed seedlings are small (up to 4-leaf stage). Apply alone or tank mix with atrazine until corn is 25 cm tall. Do not add oil concentrate. Water volume 60 L/ac. Some scorching of leaves likely to occur.
Pardner (280 g/L bromoxynil)	400 to 500 mL/ac (.98 to 1.2 L/ha)	Post	

When tank mixing atrazine with oil to form an oil-water emulsion, it is important to follow the proper mixing procedure. When filling the spray tank with water, sufficient space should be left for the atrazine and oil. Secondly, the agitation system should be engaged and only then the atrazine added to the spray tank. The emulsifiable oil or oil concentrate should be added last

Growers should note that some products control grasses only, eg., **Dual & Sutan +**, whereas others control broadleaf weeds only, eg., **Pardner, Torch, Kil-Mor, Buctril-M** and **2,4-D**. In many instances, a satisfactory weed control program can be formed by selecting the required herbicides for a tank-mix or following preplant incorporated or preemergence treatments with a postemergence herbicide.

Insect control

Corn earworm

Greenish to brownish worms marked with light and dark stripes. Eggs are laid on exposed green silk. Larvae feed on cob. An occasional pest.

Apply one of the following treatments:

Ambush 50 EC at 80 to 180 mL in 130 to 180 L water/ac (200 to 275 mL in 325 to 450 L water/ha) (1 day). Obtain good coverage of ears and silks, or

Thiodan 4 E, 40 EC at 1.1 L/ac (2.8 L/ha) (7 days). Do not ensile or feed crop refuse to livestock. Do not apply more than twice per season, or

Lannate L (Nudrin) 21.5 SN at 0.7 to 1.1 L/ac (1.8 to 2.6 L/ha) (3 days). Spray whorls as needed and silks at 2-4 day intervals or as needed.

Alternative chemicals and formulations: **Pounce 38.4 EC** (1 day); **Thiodan 50 WP** (7 days); **Lannate 90 WP** (3 days); **Sevin 5 DU, 50 WP, 80 WP, 48 SU** (1 day).

European corn borer

Dirty white larvae with small circular patterns which feed both on leaves, stalks and ears. Eggs are laid on the undersides of the leaves. A serious pest which has gained a foothold in southern Alberta in the last few years. Timing of sprays is critical. Consult labels for details.

Apply one of the following treatments:

Ambush 1 G at 4 kg/ac (10 kg/ha) (1 day). Apply no later than when first feeding is seen on the foliage. Repeat in 5-10 days, or

Ambush 50 EC at 80 to 180 mL in 130 to 180 L water/ac (200 to 275 mL in 325 to 450 L water/ha) (1 day). Apply no later than when first feeding is seen on the foliage, or

Lannate L (Nudrin) 21.5 SN at 1.0 L/ac (2.6 L/ha) (3 days). Spray at 3-5 day intervals as needed.

Alternative chemicals and formulations: **Pounce** 38.4 EC (1 day); **Lannate 90** WP (3 days); **Sevin** 5 DU, 50 WP, 80 WP, 80 WP, 48 SU (1 day); **Furadan** 48 SN (7 days); **Dylox** 80 SP (1 day); **Rotenone** 1 DU (1 day).

Seedcorn maggot

Small, legless, white fly maggots which chew out seeds and prevent germination.

Apply the following material:

Counter 15G at 75 g/100 m row (0.8 oz/100 ft row) at a minimum 75 cm (2.5 ft) row spacing. Place in 18 cm (7 in.) band over row as directed, at seeding only.

Grasshoppers

Apply the following material:

Furadan 48 SN at 110 mL/ac (275 mL/ha) (7 days).

Disease control

Holcus spot

Follow a two-year rotation that avoids corn, sorghum species, foxtail millet, sudan grass and Johnson grass. Rotate with broadleaf crops. Maintain high levels of potassium. Overhead irrigation increases the chance of disease spread.

Root and stalk rots

Rotate one or more years excluding cereals and grasses. Control plant numbers as high populations can cause stress on individual plants which tend to have an increase on stalk rot and lodging. Maintain balanced soil fertility. High nitrogen and low potassium levels increase the risk of stalk rot.

Seed rot and seedling blight

Follow a regular crop rotation. Delay seeding until soil temperature is above 10°C. Avoid planting in heavy, poorly drained soils. Treat seed with Captan, Thiram, Dexon, Dithane M-45, Manzate 200 or Pro Gro before planting.

Smut (Head and Common)

Follow a two-year crop rotation with broadleaf crops. Avoid injuring plants during cultivation. Maintain balanced soil fertility avoiding high nitrogen. When practical, remove and destroy diseased plants as they are observed. Clean harvesting equipment thoroughly before entering a clean field. Plant seed treated with carbathiin + thiram.

Special problems

Handling fresh market corn after harvest

During warm weather, sweet corn quality deteriorates very quickly after harvest. The high amounts of sugar in the kernels rapidly change to starch. Sugar levels can start to go down within an hour of harvest and noticeable deterioration can take place within hours. Unfortunately many sweet corn growers do not take simple steps to prevent this problem. Super sweet varieties initially have a much higher sugar content and are therefore sweeter tasting over a longer postharvest period.

The complete change-over from sugar to starch is almost completely stopped if the temperature of the corn is brought down to 2-5°C within an hour of harvest and then maintained at this low level or cooler during shipping and marketing.

The removal of field heat is best done by flushing graded and bagged corn with iced water (0-1°C). This process is called hydrocooling. The key to hydrocooling is using enough ice to maintain low water temperatures and flushing the corn for a long enough time to bring the temperatures down.

Hydrocoolers are commercially available or may be custom made by growers.

Storage and handling

Sweet corn should not be stored, but can be held for shipment for one or two days at 0°C and a relative humidity greater than 95%.

Sweet corn **should be hydrocooled** to remove field heat and **improve quality**.(See above).

Grade and packaging standards

The following is a guide and has no official sanction.

The only grade for sweet corn is Canada No. 1. Generally Canada No. 1 Sweet corn has similar varietal characteristics; is free from ears that are misshapen; has ears on which the undeveloped ends do not exceed one quarter of the length of the ear; has ears on which the appearance and quality of the edible portion is not affected by poorly developed kernel rows; has ears which have kernels of fairly uniform development; is well covered with fresh unbroken green husks or if the husks have been removed, is protected by transparent wrappers; is free from injury, decay or defect; has a minimum of 10 cm (4 in.) of edible corn on each ear. Packages containing corn must be marked "Canada No. 1 grade Sweet Corn--Small" if ears have a minimum length of 10 cm (4 in.) and a maximum of 15 cm (6 in.) of edible corn.

A series of general tolerances also affect the grade of corn. Units of corn may be packed in 1/2 dozen, 1 dozen and 1 dozen plus multiples of 1/2 dozen in bags, boxes, cartons or crates.

CUCUMBERS, SQUASH, PUMPKIN, MUSKMELON, WATERMELON

Varieties

Pickling cucumbers:
Earlipik, Greenpak, Pioneer, Pickmore, Compass.
Slicing cucumbers:
Slicemaster, Victory, Abbott & Cobb Improved, Dasher, Roadside Fancy.
Summer squash:
(most summer squash are bush types)
Green zucchini types - Ambassador, President, Zucchini Select
Yellow crookneck types - Goldneck, Cracker
Yellow straightneck types - Goldbar, Goldzini
Patty-pan or scallop types - Scallopini, Early White Bush Scallop
Other summer squash - Vegetable Marrow, Cousa
Winter squash:
Acorn or Pepper type - Table King (bush), Jersey Golden Acorn (bush).Tay-Belle
Buttercup types - Kindred, Buttercup, Sweet Mama
Hubbard types - Golden Hubbard, Baby Hubbard Kitchenette
Butternut types - Early Butternut (semi-bush), Eastern Butternut
Delicious types - Golden Delicious, Green Delicious
Other winter squash - Vegetable Spaghetti, Banana Squash, Golden
Pumpkin:
Normal - Autumn Gold, Jackpot, Jack O'Lantern, Spirit (bush)Pie - Small Sugar, Spookie (bush)
Naked Seeded - Trick or Treat
Ornamental - Sweetie Pie
Muskmelon:
Maine Rock, Alaska, Northern Queen, Early Dawn
Watermelon:
Stokes Sugar, Yellow Baby (yellow flesh), Sugar Baby

Seed treatment

Purchase treated seed or treat with Thiram or Captan according to manufacturer's directions.

Seeding, planting and spacing

The vine crops are warm-season crops and soil temperatures must be 16°C or higher before germination occurs. They have no frost tolerance and ust be planted after all danger of frost has past.

Pickling cucumbers will mature from seed in most areas of Alberta. However, their production can be less risky, earlier and higher yielding, especially in central and northern regions, if they are grown with the aid of transplants, mulch, tunnels, hotcaps or some combination of these. Refer to Section 1 of this guide for details on the use of hotcaps and plastic tunnels.

In southern regions slicing cucumbers, squash and pumpkin will mature well from seed. In central and northern areas of the province, these crops will require transplanting and some form of plant protection such as plastic mulch, tunnels or hotcaps. In southern Alberta yield and earliness of slicing cucumbers is increased with the use of transplants.

Muskmelon and watermelon should be started in 7 cm (3 in.) peat pots about 2 weeks before field setting Mulch, hotcaps and tunnels will improve yield and earliness.

Fertilizer

Growers should always base fertilizer application rates on the results of annual soil tests.

Prior to planting, broadcast and work in 45 kg/ac (110 kg/ha) of 34-0-0 and 100 kg/ac (250 kg/ha) of 11-55-0 or the equivalent.

Sidedress with 35 to 40 kg/ac (85 to 100 kg/ha) of 34-0-0 when plants start to run. This later application can be applied through the irrigation system.

Weed control

Cucumbers only. Apply **Dyanap** 330 g/L (naptalam + dinoseb) at 5.6 to 7.0 L/ac (14.0 to 17.0 L/ha) in 80 to 160 L/ac (200 to 400 L/ha) of water, preemergence, i.e., after planting but before crop emerges. Controls annual broadleaf weeds and some annual grasses (Table 7, p. 32). If soil is cold at time of seeding delay Dynap application until soil temperature warms up. Crop injury may occur if heavy rainfall occurs shortly after application. Dyanap will generally control the first flushes of purslane, but purslane control dissipates after about six weeks. Dyanap when used in conjunction with clear plastic mulch is applied at the same rates listed above. It is applied before the mulch is laid and before seeding the crop. Dyanap, when applied under clear plastic mulch has been less injurious to the crop than similar treatments without plastic mulch.

Alanap-3 (naptalam) 240 g/L. Apply Alanap-3 at 4.4 to 12.1 L/ac (11.0 to 30.0 L/ha) as a preemergence treatment after planting. Alanap-3 may be used on cucumbers, melons, squash and pumpkin. Do not use on Butternut squash. Do not apply during very wet and cold weather as stunting of the crop may occur. Where clear plastic mulch is used, the herbicide should be applied before the mulch is laid and prior to seeding. Alanap-3 controls lamb's-quarters, pigweed, purslane and green foxtail. Tests at the Alberta Horticultural Research Center have shown that Alanap-3 causes unacceptable injury to pumpkin and squash seedlings when grown without clear plastic mulch. Although Alanap-3 is registered for pumpkins, squash and melons, its use in Alberta is not recommended.

Dyanap and Alanap-3 are used on an extremely limited basis in Alberta, consequently growers encounter difficulty in locating a supplier. These products are manufactured by Uniroyal and are available from the following sources:

Jorgensen Fuel & Fertilizer Ltd.
3110 - 1 Avenue, South
Lethbridge, Alberta T1J 4H3
phone: 327-3535

Zaychuk Farms Ltd.
24191 - 34 Street
Edmonton, Alberta T5Y 2L3
phone 973-6440 (Dyanap only)

Amiben DS (chloramben 75%) is registered for use as a preemergent treatment after planting for pumpkin and squash. Apply Amiben DS at 1.2 kg/ac (3 kg/ha) in 40 to 60 L/ac (100 to 150 L/ha) water. Further work is required to determine the efficacy of this product for use under clear plastic mulch. Amiben DS is a product of Union Carbide Agricultural Products (Canada) Ltd.

Cucumbers Only - **Prefar** (bensulide 480 g/L) controls barnyard grass and green and yellow foxtail. Prefar at 3.8 to 5.7 L/ac (9.5 to 14 L/ha) should be tank mixed with Alanap-3, 3.8 to 7.7 L/ac (9.5 to 19 L/ha) in 40 to 160 L/ac (100 to 400 L/ha) water. Incorporate lightly 1 to 3 cm into the soil just prior to planting. Use the lower rate on sandy soils. Do not apply Prefar more than once every 12 months. To avoid crop injury, rotate only to cucumbers, peppers, cole crops, carrots, lettuce, tomatoes, pumpkin or squash. Prefar 4.8 E is a product of Stauffer Chemical Company, Approximate seed requirements per hectare (per acre) are:

	Transplants	Direct Seeded
Pickling cucumbers	1-2.5 kg	4.5-5.5 kg
	(1-2 lb)	(4-5 lb)
Slicing cucumbers	1-2.5 kg	3.5-4.5 kg
	(1-2 lb)	(3-4 lb)
Pumpkin & squash	2.5 kg	3.5-4.5 kg
(large seed)	(2 lb)	(3-4 lb)
Pumpkin & squash	1-2.5 kg	1-3.5 kg
(small seed)	(1-2 lb)	(1-3 lb)
Muskmelon	1-2.5 kg	-
	(1-2 lb)	
Watermelon	1 kg	-
	(1 lb)	

Seed sizes vary greatly and seed counts per kg (per lb) will help in determining amounts required.

Insect control

Cutworms on cucumbers

Usually red-backed cutworm which cuts off plants at or below ground level in spring.

Apply one of the following materials:

Preseeding

Lorsban 4E, 48 EC 970 mL/ac (2.4 L/ha) (60 days). Apply once 3-7 days before planting or transplanting. Do not incorporate.

Postseeding or transplanting

Lorsban 4E, 48 EC at 480 to 970 mL in 80 to 160 L water/ac (1.2 to 2.4 L in 200 to 400 L water/ha) (60 days). Apply once at 2 to 5 leaf stage

Alternative chemicals and formulations: **Lorsban 25 WP** (60 days).

Disease control

Angular leaf spot

Use disease-free seed grown in a dry area if possible. Turn under crop refuse promptly after harvest. Follow a 3-year crop rotation. Do not work in the crop when foliage is wet. The pickling variety Pioneer is resistant to angular leaf spot. At first sign of disease, apply Kocide 101 50 WP at 0.9 to 1.3 kg/ac (2.2 to 3.3 kg/ha) (1 day), C.O.C.S. 50 WP at 1.3 to 1.8 kg/ac (3.3 to 4.5 kg/ha) (1 day) or Chem Cop 53 WP 1.1 to 1.3 kg/ac (2.8 to 3.3 kg/ha) (1 day) and repeat at weekly intervals or as required.

Damping-off

Use steamed or fumigated soil or synthetic mix for starting plants. Avoid seeding in cold, wet soil. Treat with Captan or Thiram seed protectants.

Plant cucumbers 1-2 cm (0.5-1 in.) deep. Squash and pumpkins are planted 2-5 cm (1-2 in.) deep. The following are approximate final spacings for vine crops:

	Between Rows	With in rows
Pickling cucumbers	1-2 m	8-15 cm
	(4-6 ft)	(3-6 in.)
Slicing cucumbers	1-2 m	30 cm
Summer squash	1-1.5 m	45-60 cm
(bush types)	(4-5 ft)	(18-24 in.)
Bush pumpkin	1-2 m	90 cm
	(3-4 ft)	(3 ft)
Vining pumpkin	2-2.5 m	60-90 cm
squash	6-8 ft)	(2-3 ft)
Muskmelon	2 m	60 cm
	(6 ft)	(2 ft)
Watermelon	2 m	60 cm
	(6 ft)	(2 ft)

Wilt

Use disease-free seed. Start plants in steamed or fumigated soil. Avoid fields known to be infested with wilt fungi. Check seed catalogues for wilt resistant varieties.

Special problems

Pollination

All vine crops depend on insects to transfer pollen from the male to female blossoms. In small plantings, there may be enough native insects to perform the service. In large plantings, growers should provide one colony of honey bees for every 0.5-1.5 ha (2-3 ac) to ensure adequate pollination.

Storage and handling

Cucumbers and summer squash should be stored at 7-9°C and more than 95% relative humidity. A storage life of 10-14 days can be expected. Cucumbers and summer squash are sensitive to chilling injury at temperatures below 7°C. Avoiding moisture loss is important.

Muskmelons store best at 0-7°C and 90% relative humidity. Muskmelons normally have a storage life of approximately 2 weeks at 0°C. Some varieties may, however, suffer from low temperature breakdown at 0-7°C. Only mature melons should be stored.

Pumpkins and winter squash store best at 7-10°C and 70-75% relative humidity. Pumpkin and winter squash should be cured for 2 weeks at 25-30°C to aid the healing of minor injuries. After curing, temperatures should be reduced to the 7-10°C range. Storage life of pumpkin and squash depend largely on their type and variety.

Grade and packaging standards

The following is a guide and has no official sanction.

There are no grades for fresh pickling cucumbers, squash, pumpkins and melons, however, growers should only offer fresh quality produce free from decay, insects, injury and other defects.

The grades for field cucumbers are Canada No. 1 and Canada No. 2. Generally Canada No. 1 field grown slicing cucumbers are fresh, sound and firm; are straight, and not constricted, tapered or pointed, and are green in color over 85% of the area; are free from damage, decay and sunscald; do not vary more than 2 cm (0.75 in.) in diameter and 5 cm (2 in.) in length when in a package; have a minimum diameter of 6 cm (2.75 in.) and minimum length of 15 cm (6 in.).

Canada No. 2 cucumbers are similar to Canada No. 1, but require green color on only 75% of surface area and have a minimum length of 10 cm (4 in.). Diameter restrictions do not apply. A set of general tolerances apply to these grades. There are no official package sizes for field cucumbers.

LETTUCE

Varieties

Crisphead or Iceberg types: Great Lakes, Ithaca, Mesa 659
Butterhead types: Buttercrunch, White Boston
Cos lettuce: Paris White
Leaf lettuce: Grand Rapids, Salad Bowl, Ruby, Red Sails

Seed treatment

Purchase treated seed or treat with Captan or Thiram seed treatments following manufacturer's directions.

Seeding, planting and spacing

Lettuce seed will germinate at soil temperatures over 4°C and can be planted early.

Lettuce is direct seeded or transplanted.

Direct seeded using a drill type seeder requires 0.5 to 1.0 kg/ac (1 to 2 kg/ha). Lettuce seed can be pelleted for use with a belt-type precision seeder. The amount of pellets required will depend on pellet size, seed germination and spacing required. Plant lettuce seed 1 cm (0.5 in.) deep.

Well hardened lettuce transplants will withstand spring frosts and can be field set relatively early (April 25-May 15). Transplants should be seeded about 4 weeks prior to field setting. Either direct seeded or transplanted crops that mature during hot weather may deteriorate rapidly in the field. Leaves brown and heads may sunscald in extreme heat.

The final spacing should be from 30-60 cm (12-24 in.) between rows and 30 cm (12 in.) apart in row.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting, broadcast and work in 100 kg/ac (250 kg/ha) of 11-55-0 and 100 kg/ac (250 kg/ha) of 34-0-0 or the equivalent.

Weed control

CIPC (chloropropham 480 g/L at 3.8 L/ac (9.4 L/ha) in 60 to 120 L/ac (150 to 300 L/ha) of water on a trial basis. CIPC is registered to control some annual broadleaved weeds and some annual grasses. Apply after seeding but before emergence. May cause crop injury and delayed maturity in cool, wet weather. Overhead irrigation is required after application.

Insect control

Aphids

Green, yellow or pink species which feed on inner leaves. If problems have been experienced in previous years, follow continuous program during growing season. Keep plantings away from greenhouses and urban areas.

Apply one of the following as a foliar spray and alternate between chemical groups:

Monitor 48 SN at 445 to 930 mL/ac (1.1 to 2.3 L/ha) (14 days). Apply at 7-10 day intervals.

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (3 days), or

Pirimor 50 WP at 120 to 200 g/ac in 200 to 400 L water (300 to 500 g/ha in 500 to 1000 L of water) (7 days). Repeat if necessary.

Alternative chemicals and formulations: **Cygon** (System) 48 EC (7 days); **Systox 24 EC, 72 EC** (21 days); **Thiodan 50 WP, 40 EC** (14 days); **Malathion 25 WP, 85 EC, 4 DU** (3-14 days); **Dibrom 86.4 EC, 65.4 EC** (4 days).

Cutworms

Apply the following material:

Ambush 50 EC at 60 mL/ac (140 mL/ha) (1 day). Where cutworms are large or soil conditions are dry use 90 to 120 mL/ac (225 to 300 mL/ha). Do not disturb soil surface for 5 days after treatment.

Leafhoppers

Small, pale yellow flying insects which are only of significance if they transmit aster yellows mycoplasma. Plant away from cereal crops where leafhoppers breed. Rogue out infected plants.

Apply one of the following materials as foliar sprays if necessary:

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (3 days), or

Malathion 25 WP at 1.1 to 2.2 kg/ac (2.75 to 5.5 kg/ha) (3-14 days), or

Thimet 10 G at 4.5 kg/ac (11 kg/ha). At planting time only. Do not place in direct contact wtih seed.

Alternative chemicals and formulations: **Malathion 85 EC**, 4 DU (3-4 days); **Thimet 15 G** (P), **Sevin 43 SU, 50 WP, 85 WP** (14 days); **Methoxychlor 50 WP** (14 days).

Disease control

Fungal rots

Turn under crop refuse promptly after harvest. Avoid poorly drained fields and overcrowded planting. Discard heads with any trace of infection at harvest. Avoid sprinkling crops during mid day and crop maturity. Pre-cool promptly after harvest.

Storage and handling

Lettuce stores best at 0°C and relative humidity greater than 95%.

Head lettuce can be stored satisfactorily for up to 3 weeks if field heat is rapidly removed and a 0°C temperature is maintained.

Preventing moisture loss by the use of plastic bags should also be considered.

Grade and packaging standards

The following is a guide and has no legal sanction.

The grades for head lettuce are Canada No. 1 and Canada No. 2. Generally, Canada No. 1 head lettuce has similar varietal characteristics; has wrapper leaves that are not wilted; has compact heads; in the case of crisphead types has no more than 8 wrapper leaves; is free from split heads; is free from decay or tipburn; is free from injury; when packaged has heads that do not vary morethan 5 cm (2 in.) in diameter.

Canada No. 2 lettuce has more tolerance to injury and defect and no limitation on size variation in a pack.

A series of general tolerances exist for these grades.

There are no standard packages for lettuce although it is usually packed by count in cartons.

ONIONS

Varieties

Yellow Globe cooking onions: Norstar, Improved Autumn Spice,

Spanish types (fall seeded or transplants only): Cima, White Sweet Spanish, Sweet Sandwich

Bunching onions: Hardy White Bunching, Japanese Bunching, White Lisbon, White Spanish Bunching

Pickling onions: White Barletta, White Pearl

Seed treatment

Purchase treated seed or treat with Captan or Thiram seed treatments following manufacturer's directions.

Seeding, planting and spacing

Onions will germinate at cool temperatures and can be planted when soil temperatures reach 5°C. Seeds are planted 1-2 cm (0.5-.75 in.) deep.

Dry bulb onions from seed: Dry bulb onions require a long (120 + days) season to mature and should be planted early in spring or in the fall. In the spring,they should be planted as early as April 10, or in the fall, end of October if possible. Yields are significantly reduced if seeded after about May 1.

Dry bulb onions are best seeded with a belt type precision seeder. Seeds are planted about 5 cm (2 in.) apart in a double line using a double row shoe and belts punched with two rows of holes. Number of holes and hole size varies as planting requirements and seed size vary. About 2-3 kg of seed are required per hectare (2-3 lb/ac).

Rows for dry bulb onions have traditionally been 45-60 cm (18-24 in.) apart depending on equipment available. Recent trends are for onion rows to be planted as close as 25-30 cm (10-12 in.) apart in beds containing 5-6 rows. Complete chemical weed control is necessary if the narrow row spacing is used. The close spacing tends to increase yields and promote earlier maturity. Bulb size can be reduced at close spacings.

Transplanting onions: Standard dry bulb varieties in northern areas and Spanish type onions in all areas of the province need to be planted as transplants if they are to mature. Seeds should be started in flats about 6-8 weeks prior to planting. Seedlings should be field set from about May 1 to 15. Space plants 10-15 cm (4-6 in.) apart in rows that are 45-60 cm (18-24 in.) apart.

Bunching and pickling onions: These onions should be planted as early as possible in the spring. High populations of evenly spaced plants result in good yields of uniform onions. A belt-type precision seeder is best for seeding bunching and pickling onions. Seed reqirements range from 20 to 30 kg/ac (45 to 70 kg/ha) but may vary depending on seed size and row spacing used.

More detailed information on production of onions is available in a factsheet titled *Commercial Onion Production* in Alberta, FS 258/20-5.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting, broadcast and work in 35 lb/ac (90 kg/ha) of 11-55-0 or the equivalent.

For direct seeded dry bulb onions, the preplanting application of 11-55-0 can be reduced and some of the 11-55-0 can be banded to the side and below the seed at the time of planting.

Dry bulb onions may require an additional side dress application of nitrogen in July. Apply 10 to 15 kg/ac (30 to 35 kg/ha) of nitrogen either as a side dress application or about 35 kg/ac (85 kg/ha) of 34-0-0 applied through the irrigation system.

Weed control

Hoe Grass 284 (diclofop methyl 284 g/L). Dry bulb onions only. Apply 1.4 L/ac (3.5 L/ha) in at least 40 L/ac (100 L/ha) water at 275 kPa (40 psi). Controls wild oats, green and yellow foxtail and barnyard grass. Apply when weeds are in the one to four leaf stage and before they tiller. Other postemergence herbicides must be applied at least four days after Hoe Grass 284 application. Do not apply if rain is expected within one hour. The Hoe Grass rate for onions is higher than that for field crops because of the low competitive ability of onions.

Poast (sethoxydim 184 g/L) is registered for the control of grasses in dry bulb onions. The maximum recommended rate is 1.78 L/ac (4.4 L/ha). The time between application and harvest should be 50 days or more. For information on specific rates check the bean section on weed control.

Goal (192 g/L). Use in dry bulbs only. Apply 253 mL/ac (625 mL/ha) when the onions have two fully developed true leaves and weeds are small. Growers relying on Goal for broadleaved weed control should consider applying Gramoxone prior to crop emergence to kill emerged weeds. Repeated applications are required whenever a new flush of weeds appear. Do not apply in excess of 1 L/ac (2.5 L/ha) or within 56 days of harvest. Goal is available through Pfizer dealers. Growers in southern Alberta should telephone the Pfizer dealer in Lethbridge at 381-2383.

Insect control

Onion maggot

A small, greyish fly lays eggs at the base of the plant. Small white maggots feed in the onion bulb and may introduce rots.

A. Onions grown from seed

Use seed + foliage, furrow + foliage, or foliage treatments alone. All onion seed must be treated with a sticker to hold the insecticide on the seed. If a fungicide is also being applied it should be applied before the insecticide.

Seed treatment

•Preparation of the sticker:

Add **Methocel** (grade 25 Methyl cellulose) at 50 g/L (8.0 oz/gal) of hot water and let stand overnight at room temperature.

Add 60 mL (1 fl oz) of the Methocel solution per kg (lb) of seed. Mix until all the seeds are coated and shiny black.

Insecticide	Rate g/100 m (oz/1000 ft) of Row	kg/ac (kg/ha) for Row Width in. (cm)			
		12 (30)	14 (35)	16 (40)	24 (60)
Diazinon 5G	85 (9.0)	11.3 (28)	10 (25)	9 (22)	5.7 (14)
or,					
*Dyfonate 10G	57 (6.0)	7.7 (19)	7 (17)	6 (15)	3.6 (9)
or,					
Ethion 5G	134 (15.0)	10.5 (26)	12 (30)	14 (34)	21 (51)
or,					
*Dasanit 15 G (Dry bulb only)	30 (3.0)	2.4 (6)	2.6 (6.5)	3 (7.5)	4.5 (11)

- Addition of insecticide:

Add **Diazinon 50 WP** at 125 to 200 g/kg (1.0 to 3.5 oz/lb) of seed. Mix well. Do not store treated seed for longer than 3 weeks, or **Ethion 25 WP at 1 kg/4 kg (1 lb/4 lb) of seed.

Furrow drench treatment

Diazinon 50 EC at 0.9 to 1.8 L/ac (2.2 to 4.4 L/ha) or 70 to 100 mL/500 m of row at 40 cm row spacing (2.0 to 3.0 fl oz/500 yds of row at 15 in. row spacing) at seeding or planting time.

Furrow granular treatment

Growers equipped with multiple row seeders or transplanters and granular chemical applicators should use this treatment. Place one of the following insecticides in the furrow with the seed or transplant at planting time:

Alternative chemicals and formulations: Furadan 10G (dry bulb only), Trithion 10G, Lorsban 15G*.

** Not on label and apparently not a registered use. Included in B.C. recommendations.

Foliage treatment

Because of erratic results which may occur with furrow treatment, emphasis must also be placed on spraying foliage to kill onion maggot flies. In Alberta, the exact emergence time of maggot flies is not known. In British Columbia, three foliage sprays are applied at 10 day intervals as soon as the first dandelions start to flower.

An additional three sprays are applied at 10 day intervals beginning the third week of June. One or two further sprays may be necessary starting the first week of August if the crop is not lifted before September. The headlands around the fields should also be sprayed each time. Apply one of the following materials:

Diazinon 50 EC at 445 mL/ac (1.1 L/ha) for adult flies, or

Dibrom 86.4 EC at 220 mL/ac (550 mL/ha) for adult flies.

B. Onions grown from sets, multipliers or transplants

Use the furrow + foliage treatments or the foliage treatments alone, as given earlier.

*NOTE: Do not use **Dyfonate** 10G on pickling and green bunching onions or on onions grown from sets or on soils with less than 10% organic matter.

Do not use **Lorsban** 15G or **Dasanit** 15G on green bunching onions or on onions grown from sets.

Onion thrips

These are tiny black or yellow insects causing silvering of leaves and damage to bulbs in storage.

Apply one of the following materials and repeat 3 times at 10 day intervals:

Diazinon 50 EC (or 50 WP) at 445 mL/ac (1.1 L/ha) (10 days), or

Dibrom 86.4 EC at 220 mL/ac (550 mL/ha) (4 days), or

Malathion 25WP at 1.70 kg/ac (4.25 kg/ha) (3 days).

Alternative chemicals and formulations: **Malathion 4 DU** (3 days); **Methoxychlor 50 WP, 24 EC** (7 days); **Rotenone 5 WP, 5 DU** (1 day).

Disease control

Basal rot

Avoid planting sets and transplants in new land which is to be used for onion production as the disease may be introduced in this way. Follow a 4 year rotation. Control onion maggots. Avoid injury to bulbs during cultivation, harvesting and storage and keep storage temperatures below 4°C.

Neck rot

Grow early maturing, tightnecked varieties. Seed as early as possible. Avoid late growth by resticting nitrogen and water after early August. Do not lift bulbs until two-thirds of the tops are down. Tops of immature or poorly cured plants should be left on the bulbs. Onions should be artificially cured in storage and the tops removed before packing and shipping. Early maturing varieties are more resistant.

Sprout inhibition

Maleic hydrazide is sold under many trade names such as **Royal MH 60SG, Gro-Tard, MH 30, Retard, Slo-Gro, Sprout-Stop** and **Malazide**. Maleic hydrazide should be applied when bulbs are fully mature, have at least 5-8 green leaves and neck is soft enough for the tops to fall if they have not already done so. The spray is applied when 50% of the tops have fallen but are still green. This usually occurs 10 to 14 days before harvest. Sprout inhibitors should be applied only to good keeping varieties as it will not improve storage life of poor keeping varieties.

Storage and handling

Dry bulb onions store best at 0-1°C and 70-75% relative humidty.

Bulb onions should be sprout inhibited with maleic hydrazide when tops start to go down. Lifting should occur after 50% of tops are down.

Bulb onions should be cured after harvest by raising temperatures to 32-34°C with adequate ventilation for a period of 10-14 days. Moisture loss during curing will be about 5% by weight.

After curing the temperature should be reduced to 0-1°C and ventilation rates reduced.

Failure to properly cure onions can result in storage losses as a result of neck rot.

Green bunching onions are best stored at 0-1°C and 95% relative humidity.

Grade and packaging standards

The following guide has no official sanction.

The grades for onions are Canada No. 1, Canada No. 1 pickling and Canada No. 2.

Canada No. 1 onions: have similar varietal characteristics; are well cured; are firm; are free from thick necks, seed stems, sprouts and decay; are free from damage; have a minimum diameter of 4.5 cm (1.75 in.) and a maximum diameter of 7.5 cm (3 in.). The designation of 'small' may be used for Canada No. 1 onions that have a minimum diameter of 3.2 cm (1.25 in.) and a maximum diameter of 4.5 cm (1.75 in.). The designation 'jumbo' may be used for onions with a minimum diameter of 7.5 cm (3 in.). The designation 'medium ' 5.7 cm (2.25 in.) and up or as the case may be can be used for onions with a minimum diameter of 5.7 cm (2.25 in.) or greater.

In any year onions produced and marketed before September 16 may be of lesser maturity and be less firm than onions marketed after that date and still meet the requirements of Canada No. 1 grade.

Canada No. 1 pickling onions: are similar in varietal characteristics; are cured; are firm; are free from thick necks, seed stems, decay and damage; have a minimum diameter of 13 mm (0.5 in.) and maximum diameter of 25 mm (1 in.), or a maximum diameter of 38 mm (1.5 in.), providing the package is so marked.

Canada No. 2 grade onions are similar to Canada No. 1 grade, except that they may be less mature and no maximum size designations are indicated.

The following general tolerances apply to Canada No. 1 and Canada No. 2 onions: 5% by weight may be below the prescribed or designated size; 5% by weight may exceed the maximum size, additionally 15% of the onions by weight may exceed the maximum size during July and August in any year when grown from sets and marked as 'small'; 2% by weight may be affected by decay; 5% by weight may have grade defects as related to size but including decay and still meet the grade standards. Similar tolerances are in effect for No. 1 pickling onions.

Package sizes for onions are 1.36 kg (3 lb), 2.27 (5 lb), 4.54 kg (10 lb), 11.3 kg (25 lb) bags and 22.7 kb (50 lb) bags or cartons.

PARSNIPS

Varieties

Harris Model, Hollow Crown

Seeding and spacing

Seed as early as possible in the spring at a rate of about 3-5.6 kg/ha (3-5 lb/ac). Seed 1-2 cm (0.5-.75 in.) deep. Seeds should be seeded in a double line band 7 cm (3 in.) wide. Final stands should be 20-30/m (6-10/ft). Rows are spaced 45-60 cm (18-24 in.) apart. Parsnips are a very long season crop and the rate of germination is slow. It is essential to sow early to obtain a good yield of high quality parsnips.

Soil

Parsnips, like carrots, require deep well drained soils. Soil preparation must include deep plowing to a minimum of 30 cm (12 in.). Well drained loamy sands and sandy loams are ideal for parsnips.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting, broadcast and work in up to 90 to 100 kg/ac (225-250 kg/ha) of 11-55-0 and 90 kg/ac (225 kg/ha) of 34-0-0 or the equivalent.

Broadcast about 15 kg/ac (35 kg/ha) of nitrogen as 40 kg/ac (100 kg/ha) of 34-0-0 or put about 15 kg/ac (35 kg/ha) of nitrogen through the irrigation system during the growing season.

The phosphorus fertilizer may be banded into the seedbed prior to planting.

Weed control

Afolan F (linuron 450 g/L). Apply Afolan F at 0.8 to 2.0 L/ac (1.9 to 5 L/ha) when parsnips have two or more fully developed leaves. Apply before annual grasses exceed 5 cm in height. During hot, dry weather, spray in the cool part of the day to avoid injury.

Herbicidal Oil (Shell AWK No. 1, Varsol and others). Apply 240 to 325 L/ac (600 to 800 L/ha) as an overall treatment when the crop is in the two to four leaf stage and weeds are less than 10 cm (4 in.) tall.

For further details, refer to the weed control section on carrots, p. 70 and Table 7, p. 32.

Disease control

Sclerotinia rot (drop or watery soft drop)

Rotate with resistant crops such as grasses, cereals, beets, onions, spinach or corn. Plant in well-drained soil. Use a plant spacing which will allow good air circulation among plants. Practise good field sanitation by removing and destroying diseased plants. (See COLE CROPS - SCLEROTINIA ROT)

Storage and handling

Parsnips store best at 0°C and 95% relative humidity or more. Parsnip handling should be similar to that of carrots.

Grade and packaging standards

The following guide has no legal sanction.

The grades for parsnips are Canada No. 1, Canada No. 1 cut-crowns and Canada No. 2. Generally, Canada No. 1 parsnips have similar varietal characteristics; are firm; are not trimmed into the crown but have tops trimmed no longer than 1 cm (0.5 in.); are smooth and clean; are free from cracks, damage and decay; have a minimum diameter of 2 cm (1 in.) and a maximum diameter of 7.5 cm (3 in.) with a minimum length of 12.5 cm (5 in.). Federal regulations now permit parsnips to be packaged with a minimum diameter of 4.5 cm (1.75 in.), however they must be marked as 4.5 cm (1.75 in.) and up. When packed as prepackaged products, parsnips must not vary more than 3 cm (1.5 in.) in diameter.

A series of general tolerances apply to these grades. Standard package sizes are 454 g (1 lb), 907 g (2 lb), 11.3 kg (25 lb) and 22.7 kg (50 lb) bags.

PEAS

Varieties

Fresh market:

Early - Dane, Olympia, Vulcan, Spring
Late - Bell Boy, Novella, Duet, Green Arrow, Trifect,Bolero, Dark Skinned Perfection, Headliner

Process market: As required by processors

Dry peas: Trapper, Century, Tara, Triumph, Lenca, or as required by contracting company

Seed treatment

Purchase treated seed or treat seed with Captan following manufacturer's directions.

Seed should be treated with bacteria inoculant in the drill box at seeding time to promote the development of root nodules which are required to fix nitrogen from the air.

Seeding and planting

Plant peas when soil temperatures reach 4°C or when directed by the contracting company. Normal seeding dates range from April 25 to May 10 but are delayed in the case of late processing crops.

Peas should be planted into soil moisture at about 5 cm (2 in.) deep.

Seeding rates vary considerably depending on variety, seed size, availability of irrigation and whether the peas are used for fresh market, processing or seed. Normal ranges are from 80 to 140 kg/ac (200 to 340 kg/ha). If peas are row-cropped less seed is required 20 to 45 kg/ac (56 to 110 kg/ha).

Peas grown for market gardening may be planted as a row crop at 60 cm (24 in.) between rows; planted in beds of rows 15-25 cm (6-10 in.) apart leaving a walkway between beds every 120-180 cm (4-6 ft); or they may be planted in solid plantings using a grain drill which spaces rows 15-25 cm (6-10 in.) apart. Peas grown for processing or seed are planted with a standard grain drill which spaces rows 15-25 cm (6-10 in.) apart. In all cases seeds are planted about 2-5 cm (1-2 in.) apart in the row.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting, broadcast and work in 50 kg/ac (123 kg/ha) of 34-0-0 and 35 kg/ac (85 kg/ha) of 11-55-0 during soil preparation. Drill an additional 35 kg/ac (85 kg/ha) of 11-55-0 at seeding time.

Weed control

Treflan (trifluralin 545 g/L), Rival 500, Triflurex. Apply either as a spring or fall preplant incorporated treatment. Application is the same as for beans.

Basagran (bentazon) 480 g/L. Apply after peas have three pairs of leaves. Application instructions are the same as for beans except that Citowett plus is the recommended surfactant for peas.

Hoe Grass 284 (diclofop methyl 284 g/L). Controls wild oats, green and yellow foxtail and barnyard grass. Apply 2.5 to 2.8 L/ac (1 to 1.1 L/ha) in at least 40 L/ac (100 L/ha) water with nozzles directed forward 45 degrees. Apply when weeds are at the one to four leaf stage. Other herbicides for broadleaf control must be applied at least four days after Hoe Grass 284 application. Do not apply if rain is expected within one hour.

MCPA Sodium Salt 300 g/L. Controls several broadleaf weeds (Table 7, p. 32). Apply 0.6 L/ac (1.5 L/ha) in not less than 60 L/ac (150 L/ha) of water when pea vines are 10-18 cm (4-7 in.) long. MCPA sodium salt may be mixed with Dalapon or TCA.

MCPA Amine (500 g/L). Apply 280 mL/ac (700 mL/ha) in not less than 70 L/ac (173 L/ha) of water when pea vines are 10 to 18 cm long.

Tropotox Plus (MCPB + MCPA) 400 g/L. Controls several broadleaf weeds (Table 7, p. 32). Apply 1.1 to 1.7 L/ac (2.7 to 4.2 L/ha), depending on weeds to be controlled when peas have three to six expanded nodes. Apply chemical in 60 to 80 L/ac (150 to 200 L/ha) of water.

Insect control

Aphids

Large green species clustered on growing tips, leading to stunting. May be controlled by ladybeetles and other predators. If necessary apply one of the following materials:

Pirimor 50 WP at 60 to 110 g/ac in 6.9 L of water (150 to 275 g/ha in at least 17 L of water) (6 days). Apply by aircraft.

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (1 day).

Cygon 4E, 48 EC at 110 to 170 mL/ac (275 to 425 mL/ha) (3 days).

Alternative chemicals and formulations: **Thiodan 50 WP, 40 EC** (7 days); **Malathion 4 DU, 25 WP, 50 EC, 85 EC** (3 days); **Lannate 21.5 SN** (1 day); **Systox 24 EC, 72 EC,** (21 days); **Di-Syston 72 EC** (50 days); **Dibrom 86.4 EC, 65.4 EC** (4 days); **Rotenone 1 DU** (1 day).

Spider mites

Tiny sucking arthropods on leaves. Their feeding causes loss of color and vigor. Plant away from greenhouses and urban areas.

Apply one of the following if necessary:

Phosdrin 60 SN at 180 mL/ac (450 mL/ha) (1 day), or

Dibrom 86.4 EC at 445 to 890 mL/ac (1.1 to 2.2 L/ha) (4 days), or

Malathion 50 EC at 810 mL/ac (2 L/ha) (3 days).

Alternative chemicals and formulations: **Malathion 4 DU, 25 WP, 85 EC** (3 days); **Dibrom 65.4 EC** (4 days); **Di-Syston 72 EC** (50 days).

Thrips

Tiny, slim, usually black or brown insects, which rasp flowers and leaves leaving silvery blotches.

Apply one of the following materials:

Di-Syston 72 EC at 60 to 140 mL/ac (1.5 to 3.5 L/ha) (50 days). Do not apply more than once per season or,

Rotenone 1 DU at 14 to 18 kg/ac (35 to 45 kg/ha) (1 day).

Disease control

Powdery mildew

Destroy or plow under diseased crop debris. Rotate to allow 4 years between pea crops. Seed early to avoid infection. If chemical control is required, apply sulphur 92 WP at 2.7 to 3.6 kg/ac (6.7 to 9.0 kg/ha) (1 day) as soon as symptoms appear and at 7-14 day intervals until harvest.

Root rot

Peas should not be planted on the same land more frequently than every fourth year. Plant in well-drained soil. Do not pack soil. Avoid over-irrigation. Plow under diseased crop debris. Do not crowd plants. Drill in high analysis phosphate fertilizer with the seed. If weather is cold and wet at planting, disc in 30 kg/ac (70 kg/ha) of 34-0-0 fertilizer. Refer to seed catalogues for information on resistant varieties.

Seed rot and damping off

Avoid planting in cold, wet soil. Avoid excessive irrigation. Improve the texture of heavy soil, if practical. Treat seed with Captan or Thiram.

Storage and handling

Fresh peas store best at 0°C and relative humidity greater than 95%. If peas are to be stored at all they should be stored in the pod. A storage life of 4-7 days can be expected. Peas should be cooled as rapidly as possible to remove field heat.

Grade and packaging standards

There are no federal grade standards for fresh market peas.

Generally, process peas are paid for on the basis of maturity. Prices are based on 'tenderometer' readings and are outlined in company contracts.

Dry peas grown for seed are graded by the contracting company. Growers should be aware of the requirements of the contracting company to ensure their crop management provides for the highest yield of No. 1 seed and that weed seeds and shrivelled seeds are kept to a minimum.

POTATOES

Potato production requires a high degree of management skill and technical knowledge. The following is only an outline of potato production recommendation. Growers are urged to obtain more detailed information from the Alberta Agriculture factsheets on potatoes listed at the back of this guide or to contact the potato production specialist also listed on the back of this guide. Detailed information on commercial production of potatoes is available from the piblication titled *"Potato Production Guide"*, Agdex 258/20-8.

Varieties

Russet Burbank
Primary Use: French fry
Secondary Use: Fresh market. Good baking and boiling.
Maturity: Late (120 days)
Tuber:
- Shape - Long, slightly flattened
- Eyes - Numerous; acceptable
- Skin Color - Tan
- Skin Texture - Russeted, netted
- Flesh Color - White
- Flesh Texture - Dry, mealy

Flower Color: White
Specific Gravity: High
Resistances: Moderately resistant to scab, black leg
Susceptibilities: Subject to second growth, knobbiness, hollow heart in Alberta. Susceptible to leaf roll, verticillium wilt, virus X and Y.
Storability/Dormancy: Stores well, long dormancy.

Norchip
Primary Use: Chipping
Maturity: Mid-season
Tuber:
- Shape - Round to oval
- Eyes - Shallow
- Skin Color - Creamy white
- Skin Texture - Smooth
- Flesh Color - White
- Flesh Texture - Dry, mealy

Flower Color: White
Specific Gravity: High
Resistances: Moderately resistant to scab, verticillium wilt, virus Y.
Susceptibilities: Black leg, leaf roll, virus X, growth cracks.
Storability/Dormancy: Stores well, requires sprout inhibition for long-termstorage.

Norgold Russet
Primary Use: Fresh market only. Good boiling and baking.
Maturity: Early mid-season
Tuber:
- Shape - Oval-oblong
- Eyes - Shallow
- Skin Color - Tan
- Skin Texture - Russeted, netted
- Flesh Color - White
- Flesh Texture - Dry, mealy

Flower Color: Pink
Specific Gravity: Medium to high
Resistances: High resistance to scab.
Storability/Dormancy: Stores well. Medium dormancy.

Norland
Primary Use: Fresh market only. Good boiling, fair baking.
Maturity: Early
Tuber:
- Shape - Round to oval
- Eyes - Shallow
- Skin Color - Red
- Skin Texture - Smooth
- Flesh Color - White
- Flesh Texture - Somewhat wet

Flower Color: Purple
Specific Gravity: Medium
Resistances: Moderately resistant to scab, leaf roll, verticillium wilt,viruses X and Y.
Susceptibilities: Highly susceptible to silver scurf.
Storability/Dormancy: Short dormancy. Red color tends to fade by the New Year.

Superior
Primary Use: Chipping
Secondary Use: Early fresh market
Maturity: Early mid-season
Tuber:
- Shape - Oval
- Eyes - Medium in depth
- Skin Color - Creamy white
- Skin Texture - Smooth
- Flesh Color - White
- Flesh Texture - Dry, mealy

Flower Color: Pale Lilac
Specific Gravity: Medium
Resistances: Moderately resistant to common scab.
Susceptibilities: Susceptible to verticillium wilt and potato virus.
Storability/Dormancy: Not a storage potato.

Shepody
Primary Use: French Fry
Secondary Use: Fresh market
Maturity: Mid-season
Tuber:
  Shape - Oblong to long
  Eyes - Shallow
  Skin Color - Buff
  Skin Texture - Smooth to light net
  Flesh Color - White
  Flesh Texture - Dry, mealy
Flower Color: Light violet
Specific Gravity: High
Resistances: Moderately resistance to Rhizoctonia
Susceptibilities: Susceptible to potato viruses S, X and Y, leaf roll.Moderately susceptible to common scab.
Storability/Dormancy: Currently not stored for processing.

Sangre
Primary Use: Fresh Market
Maturity: Mid-season
Tuber:
  Shape - Oval
  Eyes - Shallow
  Skin Color - Red
  Skin Texture - Slightly rough
  Flesh Color - White
  Flesh Texture - Somewhat dry and mealy
Flower Color: Lavender
Specific Gravity: Medium
Resistances: Moderately resistance to leaf roll, net necrosis, and rarely exhibits hollow heart, internal discoloration and blackspot.
Susceptibilities: Susceptible to verticillium, early and late blight.
Storability/Dormancy: Holds bright red color well past Norland.

Carlton
Primary Use: Fresh Market
Maturity: Early
Tuber:
  Shape - Oval
  Eyes - Shallow
  Skin Color - Creamy White
  Skin Texture - Smooth
  Flesh Color - White
  Flesh Texture - Somewhat wet
Flower Color: Light purple with white tips
Specific Gravity: Medium
Susceptibilities: Susceptible to common scab.
Storability/Dormancy: Early maturing and not considered a long-term storingpotato.

Yukon Gold
Primary Use: Fresh Market
Maturity: Mid-season
Tuber:
  Shape - Round
  Eyes - Shallow
  Skin Color - White
  Skin Texture - Smooth
  Flesh Color - Yellow
  Flesh Texture - Dry and mealy
Flower Color: White
Specific Gravity: High
Resistances: Resistant to mild mosaic and moderately resistant to virus leaf roll.
Susceptibilities: Moderately susceptible to common scab and virus Y.
Storability/Dormancy: Stores well, long dormancy.

Seed treatment

Seed-piece decay and surface infections of rhizoctinia and common scab on tubers can be controlled by seed treatment. Seed treatment will not protect the developing plant from other infections carried within the seed piece or from disease organisms that live in the soil.

For best results cut, treat and plant seed the same day. If cut seed cannot be planted the same day then maintain the seed at 10-15°C and a high relative humidity for 3-4 days to allow the cut surfaces to cork over. Never allow cut seed to stand in the hot sun or in drying wind.

Apply dust treatments according to manufacturer's directions or at the rate of 0.4 kg/ac (1 kg/100 kg/ha) of cut seed.

Apply one of the following:
Captan (7.5%)
Captan + Diazinon (1%)
Mancozeb (8.0%)
Easout (5.0%)
Polyram (7.0%).

Planting and spacing

Planting dates will vary from early to late May depending upon local climatic conditions, the variety, and the purpose for which the potato crop is grown. Potatoes should be planted as early as conditions permit, but soil temperatures should be at least 7°C. Cold or wet soils must be avoided if possible, as seed pieces will be subject to rot resulting in poor plant stands.

The equipment used for planting, cultivating, spraying or harvesting will govern the row spacings. Usually rows are 90-106 cm (36-42 in.) apart. The closer spacing is possible when soil moisture and fertility are adequate.

Seed pieces are spaced 23-45 cm (9-18 in.) apart in the row. The wide spacings are desirable when fertility is low and when moisture may be lacking. Close in-row spacing is required for some varieties to prevent over-sizing, growth cracks or hollow heart. Under optimum conditions a close spacing will produce greater yields. A 30 cm (12 in.) spacing has been the most accepted for Russet Burbank with irrigation and 38 cm (15 in.) spacing for dryland production.

No specific depth of planting will give equally good results under all conditions. Planting depths of 7-15 cm (3-6 in.) are commonly used, but it is important for good germination to place the seed in warm, moist soil. Shallower planting is favored on heavier soils where rhizoctinia has been a problem as quick emergence reduces possibility of infection.

Seed requirements will depend upon between-row and in-row spacings and the size of seed pieces. The following table indicates the amount of seed required to plant a hectare (acre) at various spacings and with various seed sizes.

Soils

Tuber yield, shape, grade and ease of harvesting are dependent upon the texture and other physical characteristics of the soil. Medium textured to light sandy loam and alluvial silt soils are easy to work, and do not stick to planting or harvesting equipment or to the tubers during wet digging periods. Soils that are high in organic matter tend to ensure good aeration, nutrient supply and water holding capacity. Good drainage is an essential factor of allpotato growing soils; poorly aerated water-logged soils restrict the air needed by the roots and promote soft rot. Soils that have produced potatoes infected with diseases such as scab, rhizoctinia or blackleg should be avoided.

In some areas, potatoes are grown year after year on the same land, with only the occasional utilization of cover crops. Growing potatoes continually on the same land can lead to build up of disease and insect problems. Crop rotations, particularly those including a legume, are advisable for potato production. If sod has preceded potatoes, wireworm infestations should be guarded against. Growers renting land should carefully check the cropping history to determine if any special precautions are required.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Fertilizer requirements for potatoes depend on soil type, availability of irrigation, variety and spacing. Potassium may be required on some soils when soil tests show potassium levels to be less than 140 to 180 kg/ac (340-450 kg/ha). Potassium may be required when potatoes, sugar beets and malting barley have been grown for a long time.

NUMBER OF KILOGRAMS X 100 REQUIRED TO PLANT ONE HECTARE
(NUMBER OF HUNDREDWEIGHT REQUIRED TO PLANT ONE ACRE)

Distance between rows	Space between seed pieces	Size of seed pieces		
		40 g (1.5 oz)	55 g (2 oz)	70 g (2.5 oz)
75 cm (30")	25 cm (9")	25 (22)	32 (29)	41 (36)
	30 cm (12")	19 (17)	25 (22)	31 (27)
	40 cm (15")	15 (13)	20 (17)	24 (22)
	45 cm (18")	12 (11)	16 (14)	20 (18)
90 cm (36")	25 cm (9")	20 (18)	27 (24)	34 (31)
	30 cm (12")	15 (14)	20 (18)	25 (23)
	40 cm (15")	12 (11)	16 (14)	20 (18)
	45 cm (18")	10 (9)	13 (12)	17 (15)
95 cm (38")	25 cm (9")	20 (17)	26 (23)	32 (29)
	30 cm (12")	15 (13)	19 (17)	24 (21)
	40 cm (15")	12 (10)	15 (14)	19 (17)
	45 cm (18")	10 (9)	13 (11)	16 (14)
105 cm (42")	25 cm (9")	18 (16)	23 (21)	29 (26)
	30 cm (12")	13 (12)	17 (16)	22 (19)
	40 cm (15")	11 (10)	14 (12)	17 (16)
	45 cm (18")	9 (8)	12 (10)	14 (13)

Response to fertilizer is best when all the fertilizer is applied at seeding time and placed 5 cm (2 in.) to the side and below the seed pieces.

Growers should apply 120 kg/ac (300 kg/ha) of 11-55-0 and 140 kg/ac (340 kg/ha) of 34-0-0 or the equivalent. Potassium may be required if soil tests show that potassium levels are below 180 kg/ac (450 kg/ha).

Weed control

Roundup (glyphosate 360 g/L). Before planting Roundup has been very effective either as a fall or spring treatment for control of perennial weeds. It is inactivated by soil contact and therefore does not have any residual activity. Roundup should be applied when weeds are actively growing and at the recommended stage of growth.

Eptam (EPTC) 800 g/L, 10 G (10%). **Eptam 8E** at 1.7 to 3.4 L/ac (4.2 to 8.5 L/ha) or **Eptam** 10G at 13.8 to 27.0 kg/ac (34.0 to 67.0 kg/ha) can be applied and incorporated before planting in spring, or at drag-off or as a lay-by treatment after crop emergence. Eptam 8 E can also be metered into irrigation water. Fall application is also registered, but not recommended for southern Alberta. Eptam 8E can be impregnated on granular fertilizer or mixed with liquid fertilizer. Eptam requires immediate incorporation. Refer to Table 7, p. 32 for weeds that are controlled by Eptam. To increase the control of mustards and some other broadleaf weeds, Eptam can be tank mixed with **Sencor** 5F and **Lexone** 75 DF.

Lorox L (linuron 480 g/L), **Afolan** (450 g/L). Apply before potatoes emerge, Lorox L at 0.9 to 1.8 L/ac (2.2 to 4.5 L/ha) or Afolan F in 1.1 to 2 L/ac (2.8 to 5 L/ha) in 120 L/ac (300 L/ha) of water. Refer to Table 7, p. 32 for list of weeds controlled. Requires irrigation after application.

Sencor 5F, Sencor 750 water dispersable granule, **Lexone 75 DF** (metribuzin). **Sencor 5F** at 225 mL/ha) or **Lexone 75 DF** at 140 g/ac (346 g/ha). Apply postemergence for broadleaf weed control. Apply early postemergence when weeds are small. Under irrigation, higher rates of metribuzin either pre or postemergence are permissible (see label). These products can be tank mixed with Eptam 8E for a PPI application.

Gramoxone (paraquat) 200 g/L. Refer to stale seedbed technique, p. 18.

Hoe Grass 284 diclofop methyl 284 g/L is registered as a postemergence treatment for control of wild oats, yellow and green foxtail and barnyard grass. Apply 1.1 L/ac (2.8 L/ha) when susceptible annual grasses are in the 1 to 4 leaf stage.

Poast (sethoxydim 185 g/L). Apply at the proper rate and growth stage of annual grasses as described in the snap bean section. For quack grass suppression, apply Poast when quack grass is in the 2 to 3 leaf stage at 1.8 L/ac (4.4 L/ha) not less than 50 days before harvest. Or, apply Poast at 1.09 L/ac (2.7 L/ha) plus 0.8 kg/ac (2 kg/ha) of 100% water soluble ammonium sulphate. Following with a cultivation 7 days after treatment. Do not allow spray mixture to sit overnight as the active ingredient is hydrolyzed and subsequently inactivated. Assist oil concentrate must be added to all applications of Poast including mixtures with ammonium sulphate.

Insect control

Aphids

These insects are normally only a problem in seed fields where they transmit leafroll and other diseases. For more detailed information consult AgriFax 258/625-1 *Insect Control in Potatoes.*

Apply one of the following materials:

Pirimor 50 WP at 170 to 220 g in 200 to 400 L of water/ac (425 to 550 g in 500 to 1000 L of water/ha) (7 days), or

Furadan 48 SN at 445 mL/ac (1.1 L/ha) (7 days), or

Belmark 30 EC at 90 to 130 mL in 180 to 220 L of water/ac (225 to 325 mL in 450 to 550 L of water/ha) (7 days), or

Vydate L 24 SN at 0.93 to 1.2 L in 120 to 365 L of water/ac (2.3 to 3.3 L/ha in 300 to 900 L/ha of water) (7 days).

Alternative chemicals and formulations: **Cygon 48 EC** (7 days); **Thiodan 40 EC, 50 WP** (1 day); **Malathion 4 DU, 50 EC, 25 WP, 85 EC** (3 days); **Phosdrin 60 SN** (1 day); **Monitor 48 SN** (14 days); **Temik 10G** (90 days); **Imidan 50 WP, 70 WP** (7 days); **Lannate (Nudrin) 21.6 SN, 90 WP** (3 days); **Systox 24 EC, 72 EC** (21 days); ***Di-Syston 72 EC, 15 G** (90 days); **Diazinon 50 WP, 50 EC** (14 days); **Guthion 50 WP, 12 EC, 24 EC** (7 days); **Metasystox 24 EC** (7 days); **Thimet 15 G** (P).

***NOTE**: Di-Syston: Use only on seed potatoes.

Colorado potato beetle

Adult black and yellow striped beetles overwinter and lay orange egg "rafts" on undersides of leaves. Larvae are brick red with 2 rows of black spots on either side. They also feed on foliage.

Apply one of the following materials, alternating between chemical groups:

Belmark 30 EC at 40 to 60 mL in 90 to 200 L of water/ac (100 to 150 mL in 225 to 500 L of water/ha) (7 days), or

Furadan 48 SN at 445 mL/ac (1.1 L/ha) (7 days), or

Decis 5 EC at 40 to 60 mL in 80 to 200 L of water/ac (100 to 150 mL/ha in 200 to 500 L of water/ha) (23 days). No more than 3 applications/year or,

Ambush 50 EC at 57 to 80 mL/ac (140 to 200 mL/ha) (1 day) or,

Supracide 25 EC at 445 mL/ac (1.1 L/ha) (14 days) or,

Guthion 50 WP at 220 to 345 g/ac (550 to 850 g/ha) (7 days) or,

Monitor 48 SN at 750 to 930 mL/ac (1.85 to 2.3 L/ha) (14 days) or,

Thiodan 4 E, 40 EC at 565 mL/ac (1.4 L/ha) (1 day).

Alternative chemicals and formulations: **Guthion 12, 24 EC** (7 days); **Sevin 5 DU, 50 WP, 80 WP, 85 WP** (7 days); **Temik 10 G** (90 days); **Birlane 40 EC** (7 days); **Diazinon 50 WP, 50 EC** (14 days); **Di-Syston 15G, 72 EC** (90 days); **Lorsban 40 EC** (7 days); **Dasanit 15G, 72 EC** (100 days); **Malathion 4 DU, 50 EC, 25 WP, 85 EC** (3 days); **Methoxychlor 50 WP, 24 EC** (7 days); **Dibrom 86.4 EC** (4 days); **Imidan 50 WP, 70 WP** (7 days); **Thimet 15G** (P); **Vydate L 24 SN** (7 days).

Tuber flea beetles

Small, dull black beetles which chew shot holes in the foliage from mid June. Larvae tunnel into the tubers a short distance producing surface tracks and tiny corky plugs.

These beetles have been confirmed in many areas of Alberta, primarily urban areas. They are a serious pest in British Columbia, but their damaging potential in commercial fields in Alberta is not yet known.

All of the materials listed under Colorado potato beetle will give control of tuber flea beetle, except Di-Syston. Most controls are applied primarily against adult beetles.

Wireworms

Yellowish-brown shiny worms which may chew into seed-pieces, crowns and tubers. They are most likely to be a problem the first two years after sod-breaking. They can be controlled by planting seed-treated cereals for 2 years before planting potatoes or applying one of the following materials:

Dyfonate 10G at 22.7 kg/ac (56 kg/ha) broadcast preplanting. Incorporate into the soil to a depth of 15 cm or,

Dyfonate 10G at 9.0 kg/ac (22.5 kg/ha) as an in-furrow band treatment at seeding. Use only on irrigated soil. or,

Furadan 5G at 44.5 kg/ac (110 kg/ha) as a pre-plant broadcast, or 27.3 kg/ac (67.5 kg/ha) as a band treatment at planting.

Alternative chemicals and formulations: **Dasanit 15G** (100 days); **Thimet 15G** (P).

Aster leafhopper

Small, pale yellow leafhopper which feeds on many crops and transmits aster yellows mycoplasma. Of importance only to seed growers. Avoid growing potatoes near legumes, cereals or grassy headlands. Rogue out infected plants. Leafhoppers are usually blown in from the United States from mid-June onward.

Sprays applied for potato aphid control, with the exception of Pirimor, will also control leafhoppers. In addition Ambush 50 EC at 57 to 80 mL/ac (140 to 200 mL/ha) (1 day) may be used.

Disease control

Bacterial ring rot

Plant whole, certified seed potatoes if available. If cut seed is being used, disinfect cutting knives frequently. Plant with a cup-type planter. Clean and disinfect potato storage annually and potato equipment as often as is feasible. Disinfect cutting knives frequently. For disinfection use one of the following:

	Amount per	
	L of water	gal of water
Quaternary ammonium compounds	13 mL	10 fl oz
50% Lysol	100 mL	77 fl oz
Household bleach	100 mL	77 fl oz
Formalin	25 mL	20 fl oz.

Bacterial soft rot

Control other tuber diseases with which soft rot is usually associated. Avoid mechanically injuring or freezing the tubers. Store tubers under proper conditions.

Black leg

Plant whole seed that is free from black leg. Clean and disinfect potato storage areas annually and potato equipment as often as is practical with **formaldehyde 37 SN** 1.25 L/10 L (1 pt/gal). Remove rotted tubers from seed stocks during grading.

Common scab

Use a 3-5 year rotation, preferably with legumes. Plant scab-free or treated seed on land free of scab. Use acidic fertilizers such as ammonium sulphate (21:0:0). Irrigate adequately, especially at the time of tuber initiation. Do not add large amounts of manure to potato soil. Do not burn refuse in potato fields. Chieftan, Russet Burbank (Netted Gem), Norchip, Norgold Russet, Norland and Viking are moderately resistant to scab. Treat seed pieces at planting with **Captan 50 WP** 3 kg/1000 L (3 lb/100 gal)--dip seed, **Polyram 7**, 1 kg/100 kg (1 lb/100 lb) of seed--dust seed or **formaldehyde 37 SN** 450 mL/100 L of water (0.45 gal/100 gal of water)--soak seed. Crops such as sugar beets also host the causal agent of scab.

Dry rot

Treat seed pieces at planting (see SEED PIECE DECAY). Harvest during dry, cool weather, and avoid bruising tubers. Store tubers for 7-10 days at 15°C to favor wound healing. Maintain humidity at 90% with adequate air circulation. Irish Cobbler and Kennebec are resistant to dry rot. Tubers going into storage can be treated with **Mertect 450 F** at 8 L/170 L (4.7 gal/100 gal). Apply 2 L spray mix/1000 kg (2 qt/2500 lb) of potatoes.

Early blight

Burn or bury severely diseased vines. Maintain soil fertility. Avoid potatoes, tomatoes or eggplants in the crop rotation for at least two consecutive years. Use seed potatoes free of the disease. Spray the foliage with a fungicide when the disease appears and continue at 10-day intervals or frequently enough to prevent the disease from becoming severe. Use **Dithane M-45 80WP** or **Manzate-200 80WP** at 0.4 to 1.3 kg/ac (1.1 to 3.3 kg/ha) (1 day), **Polyram 80WP** at 0.4 to 0.8 kg/ac (1.1 to 2.2 kg/ha) (1 day), **Difolatan 4.8 F** at 1.7 L/ac (4.2 L/ha) (1 day), or **Bravo 500** at 0.6 to 1.0 L/ac (1.6-2.4 L/ha) (7 days).

Rhizoctonia (black scurf)

Plow down a green cover crop the year before planting if black scurf has been a problem in previous years. Use disease-free seed. Avoid planting in cold, wet soil and cover seed pieces with not more than 5 cm (2 in.) of soil.

Harvest tubers as soon as they are mature. Avoid growing potatoes in fields or portions of fields where the disease has been severe. Treat seed pieces with **Captan 50 WP** 3 kg/1000 L (3 lb/100 gal of water)--dip seed, **formaldehyde 37 SN** 450 mL/100 L (.45 gal/100 gal)--soak seed, or **Mertect 450 F** at 8 L/170 L (4.7 gal/100 gal)--spray 2 L of mixture/1000 kg (2 qt/2500 lb) of potatoes.

Seed piece decay

Cut, treat and plant the seed the same day. If cut seed cannot be planted the same day, maintain it at 10-15°C and high humidity. Don't allow cut seed to be exposed to the hot sun or drying winds. Whole seed is less prone to decay than cut seed. Treat seed before planting with **Captan 50 WP** 3 kg/1000 L (3 lb/100 gal water)--dip seed, **Captan 7.5 D + Diazinon** 1% D 1 kg/100 kg (1 lb/100 lb), **Mancozeb 8 D** 1 kg/100 kg (1 lb/100 lb), **Polyram 7** 1-1.7 kg/100 kg (1-1.5 lb/100 lb) or **Easout 5 D** at 1 kg/100 kg (1 lb/100 lb). Store treated seed under well ventilated conditions.

Leaf roll

Use certified seed. Rogue infected plants. Control aphids (see INSECTS). Vine kill seed potatoes when green peach aphids first appear or as early as possible.

Special problems

Seed selection

Selection of high quality seed stock is necessary for maximum yields of commercial potatoes. Characterisitics of high quality seed are trueness to variety, freedom from seed-borne diseases, physical soundness and an approved field inspection report. The seed should have been produced under suitable growing conditions and stored at temperatures of 3-5°C. Commercial growers should always use seed that is relatively free from disease, e.g. foundation or certified. Many diseases that reduce the yield of potatoes do not produce visible symptoms on the outer surface of the tubers; that is particularly true of bacterial and virus diseases. A plant from an infected seed piece can serve as a source of infection for the spread of diseases to other plants in the field through insects or mechanical contact. Therefore, good seed is an economic asset.

Cultivation and handling

The basic reasons for cultivation of potatoes are weed control, to prevent greening of the tubers, and to enhance soil aeration. Early cultivation is desirable to control germinating weeds and to provide loose soil for later hilling operations. The rolling type of cultivator is well suited to early cultivating operations. If such a unit is not available, a light hilling followed by harrowing will destroy most weed seedlings before potatoes emerge. Later cultivation should be shallow to avoid damaging the developing root system. It is important to cultivate after irrigating to aerate and condition the soil. The number of cultivations necessary for weed control will likely decrease as selective herbicides are more commonly used.

The last one or two cultivations may be combined with hilling or ridging. Hilling is done to cover tubers to prevent them from greening, to prepare furrows for irrigation, and to protect the potatoes from frost preceding the harvest. Hilling is particularly important when furrow irrigation is used or shallow setting varieties are grown.

Vine killing

Vines are killed to hasten maturity, to facilitate mechanical harvesting, and to prevent movement of leaf diseases to the tubers.

Vine killing affects tubers in several ways:
1) Maturity is artificially hastened and harvest injury reduced.

2) Slow killing permits translocation of food from the tops and increases dry matter levels of the tubers.

3) Rapid killing cuts off food supplies to the tubers, lowers quality, and may cause stem-end discoloration.

Vine killing should be done 10 to 14 days before the desired harvest date. For a main crop variety, the treatment should be delayed as long as possible to increase yield and should not be applied over the entire field at one time but in sections of a few hectares (acres) to allow further growth of unharvested plants.

Mechanical and chemical vine killers can be used alone or in combination. Flail-type beaters kill vines instantly and machines must be adjusted carefully to minimize tuber injury. Chemicals for vine killing are **Reglone (diquat)**, Dow Potato Top Killer **(dinoseb)** and Topper **(dinoseb)**. Speed of killing by chemicals depends upon density of foliage, vine ripening, rate of application, temperature and the characteristics of chemical.

CAUTION: Vine killing chemicals are TOXIC. Read the label. Use recommended rates, and take all necessary precautions.

Harvest timing

The decision as to when to dig is often influenced by such considerations as market prospects, suitable weather, level of mechanization and availability of labor. The proper time for harvesting potatoes should be determined chiefly by the maturity of the crop.

If the crop is fully matured before harvesting, the skin of the tubers will set after the vines die and there is less likelihood of skinning and bruising. Even when harvesting a mature crop, however, precautions should be taken to avoid mechanical damage by padding the chains and elevators on the harvester, by providing a constant flow of potatoes and soil on all chains and by handling the potatoes carefully.

Mechanical injury

Special attention should be given to the proper adjustment of all conveyors and drops. Bruises are not always noticeable at harvest, but may show up after storage and result in heavy losses by lowering the grade and increasing the number of culls. Considerable knowledge and practical experience plus constant alertness and skill are required to operate any machine properly to obtain the best possible performance with a minimum of damage to the crop. Mechanical harvest injuries result in large economic losses annually to potato growers. Bruising also increases the susceptibility of tubers to diseases.

Sprout inhibition

Year-round marketing of potatoes has become a reality with the development of modern storages and of effective sprout inhibitors. At present, there are two chemicals available for use. They are maleic hydrazide, and CIPC. Maleic hydrazide is sold under many trade names such as **Royal MH60SG, De-Sprout V, Gro-Tard, MH 30, Retard, Slo-Gro, Sprout-Stop and Malazide.**

Maleic hydrazide is sprayed on the potato plant anywhere from one to three weeks after full bloom. Timing and uniform coverage are very important, therefore read the label carefully before using. CIPC can be applied in storage as a fog or as a spray after washing. If CIPC is applied as a fog, ducts should be placed in the storage before potatoes are harvested, these ducts also serve to ventilate the potato storage. For further information regarding custom application of CIPC consult your district agriculturist. It should be kept in mind that chemical sprout inhibitors cannot take the place of proper storage management and should only be used as a supplement to good storage practices.

CAUTION: Do not use sprout inhibitors on or near potatoes to be used for seed. Even in small quantities these inhibitors will adversely affect germination. Do not store seed potatoes in storages that have been treated with CIPC in the past.

Seed production

The production of potato seed requires a high degree of knowledge and management ability. Refer to Agri-Fax 258/13-1, *Seed Potato Production in Alberta* or contact the potato production specialist listed in the back cover of this guide.

Storage and handling

Storage requirements for potatoes vary considerably depending on variety, intended markets and condition of the potatoes.

Refer to Agdex 258/20-8, *Potato Production Guide* for details on potato storage requirements.

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for potatoes are Canada No. 1, Canada No. 1 large, Canada No. 1 small and Canada No. 2.

Canada No. 1 is the grade name for potatoes that: have similar varietal characteristics; are firm; are not seriously pointed, dumb-bell shaped or otherwise deformed; have skins that are well set; have no more than 10% of a lot that has more than 10% of surface flesh exposed; are reasonably clean; are free of specimens from which knobs have been removed; blight, bacterial ring rot or other decay; are free from damage (which is specifically defined); have, in the case of round varieties, a minimum diameter of 5.6 cm (2.25 in.) and a maximum diameter of 8.9 cm (3.5 in.) and in the case of long varieties have a minimum diameter of 5 cm (2 in.) and a maximum diameter of 8.9 cm (3.5 in.), except in the case of tubers longer than 8.9 cm (3.5 in.) which may have a diameter of 4.5 cm (1.75 in.) provided that in either case 60% of the specimens have a diameter of at least 5.6 cm (2.25 in.) and are properly packed.

Canada No. 1 large is the grade name for potatoes that have a minimum diameter of 7.6 cm (3 in.) and a maximum diameter of 11.4 cm (4.5 in.), but in all other respects comply with the requirements of Canada No. 1 grade.

Canada No. 1 small is the grade name for potatoes that have a minimum diameter of 3.8 cm (1.5 in.) and a maximum diameter of 5.6 cm (2.25 in.) but in all other respects comply with the requirements of Canada No. 1 grade.

Special considerations are provided for new potatoes; round varieties shipped before September 15 in any year that do not meet maturity and size requirements, and new potatoes of a long variety shipped before June 30 that do not meet maturity or size requirements and between June 30 to September 15 that do not meet maturity requirements, but in all other respects meet the requirements of Canada No. 1 grade, may be designated as Canada No. 1, provided they have a minimum diameter of 4.8 cm (1.87 in.).

A series of general tolerances apply to all Canada No. 1 grades. Five percent by weight may be below minimum size, 5% may exceed maximum size; 3% of potatoes by weight (5 % for Canada No. 1 large) may be affected by hollow heart; 1% may be affected by decay; 5% may have grade defects other than size or hollow heart, but including decay and 10% of the potatoes may have grade defects of any kind including all previously identified and still meet grade requirements.

Canada No. 2 grade potatoes are potatoes with similar varietal characteristics; are reasonably firm; are not seriously pointed or dumb-bell shaped; are free from decay; are free from damage (damage is specifically defined); have a minimum diameter of 4.5 cm (1.75 in.) and a maximum diameter of 11.4 cm (4.5 in.); have a diameter not less than 5 cm (2 in.) in 75% of the weight; have not more than one third of the lot by weight seriously affected by dirt and are properly packed.

General tolerances also exist for Canada No. 2 grade potatoes with higher tolerances for hollow heart and defects than in Canada No. 1.

Package sizes for potatoes are 2.27 kg (5 lb), 4.54 kg (10 lb), 9.07 kg (20 lb), 22.7 kg (50 lb), 34 kg (75 lb) and 50 kg (110 lb) bags or cartons. Recently added as a standard package is a 4 litre basket.

RADISH

Varieties

Champion, Cherry Belle, Comet, Icicle (white)

Seed treatment

Purchase hot-water treated seed and seed that has been treated with Thiram or Captan.

Seeding and spacing

Seed as early as possible. Continue planting at 1-2 week intervals until August 15 or September 1 to assure continued supply. Sow 1 cm (0.5 in.) deep. Plant rows 20-30 cm (8-12 in.) apart and space seeds at 40-45 per metre (12-15/ft). Four to 7 kg/ac (10 to 17 kg/ha) of seed are required.

Row spacing and seeding rates will have to be adjusted to accommodate a mechanical harvester.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting, broadcast and work in 55 kg/ac (140 kg/ha) of 11-55-0 and 45 kg/ac (110 kg/ha) of 34-0-0 or the equivalent.

Weed control

Plant into clean seedbed. Shallow cultivation may be necessary. No herbicides in Alberta are registered for use in radishes.

Insect control

Flea Beetles

Small black or black and yellow hopping beetles which chew shotholes in cotyledons and foliage. Treatment for root maggots should also control flea beetles.

If necessary apply one of the following materials:

Diazinon 50 EC at 445 mL/ac (1.1 L/ha) (10 days) or,

Diazinon 50 WP at 445 g/ac (1.1 kg/ha) (10 days) or,

Malathion 4 DU at 13.4 kg/ac (33 kg/ha) (7 days) or,

Ambush 50 EC at 56.7 mL/ac (140 mL/ha) (2 days).

Alternative chemicals and formulations: **Sevin 50 WP, 85 WP** (7 days); **Methoxychlor 50 WP, 24 EC** (7 days).

Root maggots

Grey flies lay eggs at base of young plants. White legless maggots chew into roots. Treatment is necessary in most areas of Alberta.

At seeding, apply an in-furrow granular treatment of **Diazinon 5G** at 175 g/100 m of row (18.0 kg/ac (45 kg/ha) at 38 cm (15 in.) row spacing. Ten and if necessary 20 days later drench with **Diazinon 50 EC** at 445 mL/ac (1.1 L/ha) (10 days).

Disease control

Damping-off

See cabbage disease control.

Storage and handling

Radishes store best at 0°C and humidity greater than 95%. Radishes have a storage life of 10-14 days. Field heat should be removed as quickly as possible.

Grade standards

There are federal regulations for radishes.

Growers should only offer top quality radishes for sale. Generally radishes should be fresh; firm and not pithy; uniform in size, shape and color; clean; free from damage and decay. Bunched radishes should have fresh, green leaves; should not be wilted; free from insect damage.

RHUBARB (Field)

Varities

Early Sunrise, MacDonald, German Wine (processing)

Soils, planting and spacing

A well-drained, but moisture-holding soil is required. Lighter soils will produce an earlier crop but will require more frequent irrigation. Fields should be summerfallowed prior to planting to eliminate perennial weed infestations. The field should be deep ploughed in the summer and the seed-bed prepared in advance of planting crowns.

Plants for propagation should be selected in the summer months when growing vigorously. Virus infection and other diseases reduce yield and vigor of rhubarb plants. Healthy, vigorous 3 or 4 year old crowns should be selected and divided to obtain three or more buds per seed piece.

Planting of crowns can be done early in spring or late in the fall when crowns are dormant. Crowns should be planted 7 to 10 cm (3 to 4 in.) deep, 90 cm (3 ft) apart in rows and rows should be spaced 90 to 120 cm (3 to 4 ft) apart.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Prior to planting 12 to 24 t/ha (30 to 60 t/ha) of manure should be broadcast and ploughed into the soil.

In the year of planting apply 70 kg/ac (175 kg/ha) of 34-0-0 and 80 kg/ac (200 kg/ha) of 11-55-0 or the equivalent.

In subsequent years apply 120 kg/ac (300 kg/ha) of 34-0-0 and 80 kg/ac (200 kg/ha) of 11-55-0 or equivalent.

Check fertility levels with annual soil tests.

Apply 10 t/ac (23 t/ha) of well rotted manure every 3 to 4 years. Nitrogenrates may be reduced in the year manure is applied.

Weed control

Plant into a clean field free of perennial weeds. No herbicides in Alberta are registered for use in rhubarb.

Disease control

Red leaf (crown rot)

Use disease-free crowns for planting. Dig out and destroy plants with red leaf symptoms. Harvest healthy plants first and diseased plants last to avoid spreading red leaf pathogens via harvesting equipment. Do not replant in spots where diseased plants have been removed. Keep stands vigorous and avoid unnecessary injury to the crowns during cultivation and harvesting operations.

Special problems

To maintain good plant vigor flower stalks should be cut and removed while still small.

Harvesting

Stalks should not be harvested during the first year of growth. In Alberta two major harvests can take place in early June and about mid July without affecting next year's crop. Stalks should be pulled and not cut. Leave a few leaves on each crown after harvest and [illegible] possible irrigate immediately.

RUTABAGAS (SWEDE TURNIPS)

Varieties

Laurentian, Alta Sweet

Seed treatment

Purchase hot-water treated seed which has been dusted with Captan or Thiram.

Seeding and spacing

Seed rutabagas for early market as soon as possible in the spring. Plant rutabagas for storage from June 15 to July 10. Seed 1-2 cm (0.5-1 in.) deep. Use appropriate sized seed and sow with a precision seeder that will drop single seeds at a 12 cm (5 in.) spacing. Thinning is not required with a precision seeder. Approximately 0.2 kg/ac (0.5 kg/ha) of seed is required.

Approximately 0.8 kg/ac (2.0 kg/ha) of seed is required if seeded with a drill-type seeder. Space rows 60-76 cm (24-30 in.) apart. Closer row spacing may be more productive, however, tops may bind at harvest time.

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests.

Broadcast and work in prior to planting 90 kg/ac (225 kg/ha) of 11-55-0 and 45 kg/ac (110 kg/ha) of 34-0-0. Excessive nitrogen levels will reduce root quality because rapid growth may cause root cracking.

Boron deficiency has been seen in some rutabaga crops in Alberta. Boron deficiency causes water core or brown heart. This may occur in the field or show up in storage. Boron deficiency is likely to occur in soils where pH is greater than 6.5. Boron may be added to the granular fertilizers prior to planting or applied as a foliar spray when roots are about 2 cm (1 in.) in diameter. Add about 4 to 12 kg/ac (11 to 30 kg/ha) of agricultural borax to the granular fertilizer. In addition or as an alternative, spray rutabagas with 0.2 to 0.4 kg/ac (0.5 to 1 kg/ha) of Solubor or Boro-spray following manufacturer's directions.

Boron is only required in small quantities and an overdose may be toxic to crops following rutabagas. Care should be taken in its use. Do not plant legumes or cucumbers the year following boron application.

Weed control

Members of the mustard family such as stinkweed, wild mustard, shepherd's purse and volunteer rapeseed cannot be chemically controlled in rutabagas.

Treflan (trifluralin) 545 g/L, **Rival 500, Triflurex**. Preplant incorporated treatment may be applied in fall or spring. Refer to rates and instructions given under Beans.

Eptam (EPTC) 800 g/L, 10 G (10% granular). Apply and incorporate six to ten days prior to planting. Apply 1.3 to 1.7 kg/ac (3.25 to 4.25 L/ha) or 9.1 to 13.7 kg/ac (22.5 to 34.0 kg/ha) granular product. Apply liquid in 40 L/ac (100 L/ha) of water. The granular product should be applied using a suitable granular applicator. Eptam is not persistent in the soil, it will give effective weed control for approximately six to eight weeks.

Insect control

Flea beetles

The same black beetles which attack radishes and cole crops also attack rutabagas. Only the seedling plants need to be protected.

Apply one of the following materials:

Diazinon 50 EC at 445 mL/ac (1.1 L/ha) (14 days) or

Thiodan 50 WP at 710 g/ac (1.75 kg/ha). Do not apply more than twice per season. or,

Furadan 48 SN at 35 mL in 10 L of water/100 m of row (0.5 fl oz in 100 gal/150 ft of row) or 2.0 L in 525 L of water/ac (5.25 L in 1300 L of water/ha) at 70 cm (28 in.) row spacing (40 days).

Alternative chemicals and formulations: **Diazinon 50 WP** (14 days); **Furadan 48 SU** (40 days); **Thiodan 40 EC** (45 days); **Methoxychlor 50 WP**, 24 EC (7 days); **Ambush 50 EC** (3 days).

Imported cabbageworm, diamondback moth

Green caterpillars chew holes in leaves. Where numerous apply one of the following materials:

Dipel WP at 220 to 445 g/ac (550 to 1100 g/ha). No wait period. Use a sticker and repeat at 7 to 10 day intervals as necessary. Apply when caterpillars are small or,

Dylox 80 SP at 280 to 610 g/ac (0.7 to 1.5 kg/ha) (28 days) or

Sevin 50 WP at 0.9 to 1.8 kg/ac (2.3 to 4.5 kg/ha) (14 days).

Alternative chemicals and formulations: **Dylox 42 SN** (28 days); **Sevin 48 SU**, 43 SU, 85 WP (7 days); **Malathion 4 DU** (7 days).

Root maggots

Grey-black flies which lay eggs at base of young plants from early June to early July and again during August. White, legless larvae mine roots and introduce rot organisms, rendering roots unmarketable. Preventative control measures will be necessary in most areas of Alberta. Locate crops away from canola which is an alternate host. Keep cruciferous weeds under control.

Apply one of the following materials using a combination of granular at seeding + foliar, or liquid at seeding + foliar. It is important to protect the crop during both first and second adult fly periods. When possible, seed early and harvest by first week in August.

Granular:

Dasanit 15G at 125 g/100 m (1.5 oz/100 ft) of row to a maximum of 7.0 kg/ac (17.5 kg/ha) (40 days). Apply in 10 to 15 cm (4 to 6 in.) band prior to seeding. Cultivate into top 2 to 5 cm (1 to 2 in.) of soil then seed into centre of band. Use liquid formulations for follow up sprays (See Below). or,

Furadan 10G at 175 g/100 m (2.0 oz/100 ft) of row or 10 kg/ac (25 kg/ha) with 70 cm (28 in.) row spacing (40 days). Apply in 10 cm (4 in.) band on the soil surface in front of the planter shoe and incorporate while seeding. Use a liquid formulation for subsequent sprays (See Below) or,

Alternative chemicals and formulations: **Thimet 10G, 15G** (P). In other provinces, **Birlane 10G** (40 days).

Liquid:

Dasanit 72 EC at 25 mL in 10 L water/100 m of row (0.3 fl oz in 1 gal water/100 ft of row) to a maximum of 1.72 L/ac (4.25 L/ha) (40 days). Apply in15 cm (6 in.) band after seeding and make a second application 4 weeks after planting. Make 1 or 2 additional sprays if required applying as a drench to wet crown of plant and 7.5 cm (3 in.) of soil on both sides of row. Do not apply more than 4 times in a season, or

Furadan 48 SN at 35 mL in 10 L water/100 m of row (0.4 fl oz in 1 gal/100 ft of row) or 2.0 L in 525 L of water/ac (5.25 L in 1300 L of water/ha) (40 days) at a 70 cm (28 in.) row spacing. Apply after seeding but before emergence as a coarse spray in a 10 cm (4 in.) band over the row. Repeat twice as necessary at 3 week intervals.

Alternative chemicals and formulations: **Furadan 48 SN** (40 days); **Guthion 50 WP, 24 EC** (35 days). In other provinces, **Birlane 40 EC** (40 days).

In trials in the Edmonton area, **Furadan EC** and **Burlane EC** gave good control applied as a drench at 3 week intervals, whereas **Dasanit EC, Guthion WP** and **Lorsban EC** applied similarly gave poor control.

Disease control

Black leg and black rot

Use hot water treated seed (see the section on seed treatment). Follow a 4 to 5 year rotation with noncruciferous crops. Do not apply manure containing rutabaga refuse or diseased rutabagas to land intended for production. Avoid storing diseased roots. Clean and disinfect storages each spring.

Soft rot

Avoid bruising roots as much as possible in cultivation and harvesting. Harvest under dry conditions if possible. Store at close to 0°C and 90-95% RH. Disinfect storage bins with steam, copper sulphate (2% solution) or formaldehyde 37% SN at 2.5 L/100 L (2.5 gal/100 gal) of water, prior to harvest.

Water core (brown heart)

In light, sandy soils or where boron deficiency has occurred in the past, broadcast and disc in 4 to 12 kg/ac (11 to 30 kg/ha) of agricultural borax (11% boron) prior to planting. If deficiency occurs after planting, immediately apply **Solubor** or **Borospray** (21% boron) at 500 to 1000 g/ha (200 to 400 g/ac) using 499 L/ac (1000L/ha) of water as a foliar spray. Do not plant legumes or cucumbers the year following application of boron.

Wire stem (crater rot)

Avoid injury to roots in the field and during harvest. Harvest under dry conditions if possible. Store close to 0°C and 90-95% RH. Disinfect storage bins prior to harvest (see soft rot).

Special problems

2,4-D Damage

Rutabagas are sensitive to 2,4-D and although damage or symptoms of 2,4-D spray drift may not show on the top growth the root development can be affected.

Care should be taken to place rutabaga fields away from grain crops that will be sprayed with 2,4-D.

Storage and handling

Rutabagas store best at 0°C and relative humidity of 95% or greater.

Rutabagas should store for 6-7 months at 0°C and relative humidity 95% or greater. Rutabagas can be stored in bulk or in tote bins.

Careful handling to avoid bruising will result in longer storage life. All tops must be removed prior to storage.

Grade and packaging standards

The following is a guide and has no official sanction.

The grade for rutabagas is Canada No. 1. Canada No. 1 rutabagas have similar varietal characteristics; are firm; are reasonably regular in contour and of a length not more than one and a half times the diameter; are trimmed so that tops do not exceed 19 mm (0.75 in.) and all green leafy growth has been removed and secondary roots and rootlets have been removed; are not trimmed on the upper half of the root or deeply into the flesh on the lower half; are free from insects, insect larvae, decay and damage (damage is specifically defined); have when in a package a minimum and maximum diameter as marked on the package, or have the word 'small' marked on the package where minimum and maximum diameters are 5 cm (2 in.) and 10 cm (4 in.); the words 'small medium' marked on the package where minimum and maximum diameters are 7.5 cm (3 in.) and 14 cm (5.5 in.) prior to August 31 and minimum and maximum diameter of 8.9 cm (3.5 in.) and 14 cm (5.5 in.) after August 31; the word 'medium' marked on the package where minimum and maximum diameters are 10 cm (4 in.) and 15 cm (6 in.); have the word 'large' marked on the package where minimum and maximum diameters are 12.7 cm (5 in.) and 18 cm (7 in.); except in the case of the 'small medium' size until August 31 each year when in a package do not vary more than 5 cm (2 in.) in diameter; and are properly packed.

The additional designation "waxed" may be used in connection with clean, dry rutabagas that have been completely immersed in a wax solution.

General tolerances allow that 10% of the rutabagas by count may be below the minimum size but that none can be more than 1.3 cm (0.5 in.) below the minimum, a similar tolerance applies to maximum size; 5% may be affected by decay; 10% of the rutabagas may have grade defects not including those related to size and still meet the grade standards.

Package sizes for rutabagas are 907 g (2 lb) and 2.27 kg (5 lb) bags, as well as 11.3 kg (25 lb) and 22.7 (50 lb) bags or cartons.

TOMATOES, PEPPERS, EGGPLANT

Varieties

Bush tomatoes: Brookpact, Swift, Rocket (early), Hybrid #31, Hardicross, Cherrio (cherry)

Staking tomatoes: Earligirl, Stokes Early Hybrid, Ultragirl

Peppers (hot): Hungarian Yellow Wax (yellow pointed), Red Cherry (green)

Peppers (sweet): Castle (yellow pointed), Emerald Giant (green bell), Early Prolific (green bell), Butter Belle (yellow bell), Gypsy (yellow pointed, long).

Eggplant: Dusky, Blacknite, Superhybrid

Seed treatment

Purchase hot-water treated seed and seed treated with Thiram and Captan.

Seeding and planting

Start tomatoes, peppers and eggplants 6-8 weeks prior to field setting. Germinate at 20-25°C and grow seedlings at 18-27°C during the day and 15-18°C at night. Germinate in flats containing a peat-vermiculite mixture. When seed leaves are fully developed into first true leaves (about 10 days) prick out into flats at 5 cm (2 in.) spacing or into peat pots or other seedling containers.

Plants should be hardened prior to field setting by withholding water or lowering the growing temperature.

Plant into the field after all danger of frost has passed. A preferred and more productive method is to field set tomatoes from May 15-25 and protect with hotcaps. Peppers and eggplants are best grown under plastic tunnels. Refer to Section 1 of this guide for details on how to use hotcaps and plastic tunnels.

Transplants can be hand planted or set with a mechanical transplanter.

Water-in transplants using a solution of 10-52-10 starter fertilizer. Use 110 (4 oz) per plant of solution of 2 kg (4 lb) of 10-52-10 per 230 litres (50 gal) of water.

Spacing

Tomatoes:	60-90 cm (24-36 in.) between rows
	45-60 cm (18-24 in.) between plants
Peppers:	45-75 cm (18-30 in.) between rows
	30-45 cm (12-18 in.) between plants
Eggplant:	60-90 cm (24-36 in.) between rows
	45-60 cm (18-24 in.) between plants

Fertilizer

Growers should always base fertilizer applications on the results of annual soil tests. Care should be taken in the application of nitrogen. Too much will cause excessive vegetative growth, delayed maturity, or lack of fruit set. Prior to planting, broadcast and work in up to 140 kg/ac (340 kg/ha) of 11-55-0 and 110 to 150 kg/ac (280 to 340 kg/ha) of 34-0-0 or the equivalent.

At time of transplanting, add 280 mL (4 fl oz) of a solution of 2 kg of 10-52-10 in 230 L (4 lb in 50 gal) of water or the equivalent.

Weed control

Tomatoes and peppers only. **Treflan** (trifluralin 545 EC, 400 EC g/L, **Rival 500**, **Triflurex**. Apply **Treflan 545 EC** at 0.6 to 0.8 L/ac (1.5 to 2.0 L/ha) in at least 40 L/ac (100 L/ha) of water. Incorporate within eight hours of application according to label instructions. **Trifluralin** controls green and yellow foxtail, wild oats and several broadleaf weeds (Table 7, p. 32), but it will not control plants of the mustard family such as stinkweed, shepherd's-purse and wild mustard.

Tomatoes only - **Poast** (sethoxydim). Maximum recommended rate is 1.9 L/ac (4.4 L/ha). The time period between application and harvest should not be less than 50 days. Check the section under snap beans for information on specific weeds.

Insect Control

Aphids - Tomatoes

Soft-bodied sucking insects which cluster on growing tips causing yellowing and wilting. Grow crops away from greenhouses and urban areas where green peach aphids originate.

Apply one of the following materials:

Malathion 25 WP at 0.9 to 2.2 kg/ac (2.25 to 5.5 kg/ha) (3 days) or,

Thiodan 50 WP at 445 to 600 g/ac (1.1 to 1.5 kg/ha) (2 days) or,

Systox 72 EC at 110 to 280 mL/ac (275 to 700 mL/ha) (3 days pepper and tomatoes, 7 days eggplant).

Alternative chemicals and formulations:

Tomato, eggplant, pepper: **Thiodan 40 EC** (2 days); Di-Syston 15G, 72 EC (30 to 90 days); Systox 24 EC (3 to 7 days).

Tomato, pepper: **Diazinon 50 WP**, 50 EC (1 to 5 days); Cygon 48 EC (3 to 7 days).

Tomato: **Phosdrin 60 SN** (1 day); Guthion 50 WP, 12 EC, 24 EC (2 days); Lannate 21.6, 90 WP (1 day).

Pepper: **Pirimor 50 WP** (3 days).

Colorado potato beetle - Eggplant

Primarily a potato pest but may feed on tomato and eggplant.

Apply one of the following materials:
(Tomato, Eggplant)

Thiodan 40 EC at 565 mL/ac (1.4 L/ha) (2 days) or,

Sevin 50 WP at 445 g/ac (1.1 kg/ha) (1 day).

Alternative chemicals and formulations: **Sevin 80 WP, 85 WP** (1 day); **Thiodan 50 WP** (2 days); Tomato only, **Guthion 50 WP, 12 EC, 24 EC** (2 days); **Di-Syston 15G, 72 EC** (30 days).

Climbing cutworm - Pepper

In Alberta the variegated cutworm chews holes in fruit at night. Caterpillars are large and dark brown. Corn earworm also may damage fruit.

Apply one of the following materials:

Sevin 85 WP at 0.5 to 1.1 kg/ac (1.25 to 2.75 kg/ha) (1 day) or,

Ambush 50 EC at 57.0 mL/ac (140 mL/ha) (1 day).

Diseases

Bacterial blight - Tomato

Use only hot water treated seed (50°C for 25 minutes). Grow seedlings in steamed or fumigated media in disinfected flats or pots. If any of the disease shows in a crop, carefully remove the first infected plants. Avoid methods of pruning, etc. which may spread disease from plant to plant. Avoid sprinkler irrigation. Do not replant tomatoes for at least 2 years in a field where disease appeared. At first signs of disease in the field spray with Kocide 101 50 WP at 0.9 kg/ac (2.2 kg/ha) (1 day).

Blossom-end rot - Tomato, pepper

In acid soils, ensure adequate levels of calcium by adding lime or ground limestone well in advance of planting. Maintain uniform soil moisture throughout the season. Avoid close cultivation.

Apply calcium chloride (36% Ca) at 0.9 to 2.2 kg/ac (2.2 to 5.6 kg/ha) in 1000 L (450 gal) of water as a spray during the fruit development period.

Early blight - Tomato

Plow under crop debris immediately after harvest. Follow a rotation that includes cereals and legumes. A regular spray program at 7-14 day intervals may be required in some fields. Apply **Bravo 500 F** at 1.0 to 1.6 L/ac (2.4-4.0 L/ha) (1 day), **Difolatan 4.8 F** at 1.1 L/ac (2.8 L/ha) (1 day), or **Dithane M-45 80WP** or **Manzate 200 80WP** at 0.7 to 1.3 kg/ac (1.75 to 3.35 kg/ha) (1 day).

Wilt - Tomato

Avoid moving seedlings grown in areas where wilt diseases occur to areas where they are absent. Use steamed or fumigated media and disinfect flats and pots when growing transplants. Follow a rotation where tomatoes, peppers, eggplants or potatoes have not been grown for at least 2 years. Most commercial varieties have resistance to fusarium and verticillium wilts.

Verticillium wilt - Eggplant

For transplant production, sow into steamed or fumigated soil (see ASPARAGUS - CROWN ROT). Avoid land planted to peppers, tomatoes, potatoes or eggplants for at least two years. Rotate with cereals, grasses or corn.

Special problems

Tomatoes are extremely sensitive to damage from the 2,4-D family of chemicals. Extra care should be taken to prevent fumes of these chemicals from drifting onto the crop from neighboring crop spraying operations.

Storage and handling

Tomatoes, peppers and eggplants should be stored above 7°C to prevent chilling injury. The maximum desired temperature is 10°C. Mature-green tomatoes are more sensitive than ripe, therefore they should be held at 13-16°C. Chilling injury may occur in the field, and its effect is carried over to the storage period. Relative humidity for the storage of these crops is 90% or more. Mature green tomatoes can be stored for up to 6 weeks. Peppers and eggplants can be stored for 8-10 days. Packaging of peppers in perforated plastic bags, or waxing may extend the storage and shelf life.

Grade and packaging standards

The following is a guide and has no official sanction.

The grades for field tomatoes are Canada No. 1, Canada No. 2, Canada No. 1 picklers and Canada No. 2 picklers. Separate grades exist for greenhouse tomatoes. Generally Canada No. 1 tomatoes are sound and clean; have similar varietal characteristics; are not noticeably ridged, angular or indented; are uniform in maturity when packaged; free from disease and damage, scald, water blister, bruises, soft areas, or open wet-cracks; have a minimum diameter of 5 cm (2 in.) or a minimum diameter of 3 cm (1.5 in.) and marked "small"; do not vary more than 2 cm (1 in.) in diameter when packaged.

There are no grade standards for peppers and eggplant but they should be free of disease and damage, have similar varietal characteristics, be evenly sized and neatly packaged.

Package sizes for tomatoes are 397 g (14 oz) tubes, 3.63 kg (8 lb), 4.54 kg (10 lb) and 4.54 kg (10 lb) plus multiples of 2.27 kg (5 lb) cartons, boxes or crates and 4 litre baskets. Tomatoes may also be packed in crates measuring 41 cm (16.12 in.) by 34.3 cm (13.5 in.) by 16.5 cm (6.5 in.) or cartons measuring 40.3 cm (15.87 in.) by 40.3 cm (15.87 in.) by 14 cm (5.5 in.).

SECTION 6
APPENDIX

GLOSSARY OF FREQUENTLY USED TERMS

The following are statements about the usage of terms in crop production and are not necessarily intended as definitions.

Active ingredient: That portion of a pesticide formulation that is toxic to pests. Most pesticide products contain only a portion of active pesticide-- the rest is carrier.

Annual: A plant that grows and normally forms flowers in one growing season or a crop that is planted and harvested in one growing season.

Bacteria: Very small single cell organisms that may attack plants and cause disease. Soil bacteria aid in breakdown of organic matter.

Banding: Placement of fertilizer or pesticide, at the time of planting, in a continuous band to the side and below the seed.

Biennial: A plant that requires two growing seasons to produce flowers. Celery or carrots are grown as annuals for fresh crop production but are biennials when grown for seed.

Bolting: Premature flowering of a plant. Biennial crops like celery normally produce a seed stalk in their second year. Cold temperatures in the growing season can cause bolting.

Broadcast: To spread fertilizer or pesticide over the entire area of the soil surface or the entire crop area prior to planting.

Carrier: An inert material mixed with active pesticide ingredients to make a pesticide formulation. Example: Finely divided clay or talc is used as a carrier in dust forms of insecticides.

Cultivar: A horticultural classification which means cultivated variety. In most cases cultivars are man made as opposed to naturally growing plants, e.g., Bonanza and Houston Evergreen are cultivars of cabbage. The term variety is often used (scientifically incorrectly) in crop production to mean cultivar.

Days-to-harvest: The period of time which must elapse by law between the application of a pesticide and the actual harvest of the crop.

Drift: The undirected and uncontrolled movement of spray mist that occurs at time of spraying, away from application source.

Drill: To place fertilizer or pesticide with or near seed in the seed drill or furrow.
Dust: A finely divided carrier containing a pesticide, usually in low concentration, to be used without dilution.

Emulsifiable concentrate: A liquid pesticide consisting of active ingredient, solvent and emulsifier that mixes with water to form an emulsion (e.g., diazinon 50 EC). The 50 means 50% of the volume is pesticide.

Fertigation: The process of applying soluble fertilizer materials through the irrigation system.

Fertilizer: Any material added to soil or crops that is a source of plant nutrients.

Fumigation: The use of pesticides in a gas form to destroy pests or disease organisms.

Fungi (singular fungus): A large group of simple plants which lack chlorophyll, and that require a source of material to live on. Some are parasitic and attack living plants. Soil fungi aid in breakdown of organic matter.

Germination: 1) The beginning of the growth processes of a seed once it is placed in suitable moisture and temperature conditions. 2) A term applied to the number of seeds that will germinate (given in percentage).

Graded or sized seed: Seed which is sorted within a close range of minimum and maximum sizes. The narrow size range of seed is required by precision seeders. (Note: All seed is 'graded' to remove weed seeds, poor seed and impurities.)

Granular pesticide: A pesticide formulation in the form of relatively coarse particles which is applied dry with a spreader, seeder, or special applicator (e.g., diazinon 5G).

Green manure: A crop that is grown and plowed down as a source of organic matter for the soil.

Hardening off: Refers to the practice of preparing tender, indoor-grown seedlings for field conditions, by withholding water, nutrients, or lowering temperature.

Herbigation: The process of applying herbicides through an irrigation system.

Humus: That part of organic matter in the final stages of decomposition which is normally slow to be totally broken down both physically and chemically because of its chemical composition and structure.

Incorporate: To thoroughly mix a pesticide or fertilizer with the soil so that it is uniformly concentrated to a specified depth.

LD 50: Abbreviation for the dose of a pesticide (or other toxicant) that produces a 50% kill of the organism being tested. It is usually expressed as mg per kg of body weight.

Macronutrient: An essential nutrient which is required by plants in large quantity, e.g. nitrogen, phosphorus.

Micronutrient: An essential plant nutrient which is required by plants in relatively small amounts, e.g. boron, zinc, manganese.

Mycoplasma: Bacteria-like organisms some of which cause plant diseases.

Nematicide: A pesticide to control nematodes.

Nematode: A very small worm that lives in the soil. Some species may cause severe crop damage by attacking and living in root tissue. Normal sizes range from 0.8-3 mm (1/32-1/8 in.).

Nutrient: A chemical element that is required for crop growth. There are 16 essential elements for crop growth of which 13 are obtained from the soil.

Organic matter: Plant or animal residues in varying stages of decomposition. Undecomposed plant material is normally referred to as 'trash' and doesn't become organic matter until it starts to break down.

Pelleted seed: Seed that is coated with clay, vermiculite or other substances to form uniform round or oval pellets. Irregularly shaped seeds such as carrots and lettuce seed can be coated so that they can be more accurately seeded in precision seeders.

Postemergence: After a crop emerges from the soil.

Precision seeder: A type of seeder designed to accurately place seed at a uniform spacing in the furrow.

Preemergence: The time after planting seed but before a crop emerges. Many herbicides are applied after planting but before the crop emerges.

Pricking out: Removal of transplant seedlings, usually at the appearance of the first true leaves, to individual seedling pots or to transplant flats for further growing prior to field setting.

Re-entry time: The minimum time allowed between the time of spraying a pesticide and the time at which the area may be entered by people unless protective clothing and breathing aids are used.

Residue: That portion of pesticide or fertilizer that remains in the soil or on crop plants after application. Amounts of residue decrease with time. Pesticides may leave residues from several hours to several years.

Residue tolerance: The maximum amount of a pesticidal residue that may lawfully be present in, or on, a food product offered for sale. It is expressed in parts per million.

Seed treatment: Chemical or physical treatment of seed to eliminate or reduce organisms which may cause seed decay, seedling death or disease in a growing crop. Chemical treatments include fungicide and insecticide applications to the seed. Physical treatments include immersing seed in hotwater.

Side dress: To apply fertilizer in the soil along side of a crop row after the crop is established.

Sized seed: See graded seed.

Spreader sticker: An additive used to improve the efficiency of a pesticide formulation. It may have properties that aid the spreading of a liquid over the leaf and plant surface, it also may enhance the ability to adhere to the plant surfaces.

Starter solution: A solution made up of water and soluble fertilizer, which is applied at the time of transplanting.

Sterilization: A process of chemically treating, or heating transplant soil or greenhouse soil to kill fungi, bacteria, weed seeds and other organisms that may be harmful to seedling growth.

Surfactant: A compound which increases the spreading ability of a liquid (e.g., emulsifiers, soaps, wetting agents, detergents, and spreader stickers) and aids in the effectiveness of some herbicides and insecticides. Do not use any surfactants unless they are recommended by pesticide manufacturers.

Systemic pesticides: A pesticide which is absorbed by and flows through the 'system' of a plant or animal so that the plant or animal becomes toxic to the pest to be controlled.

Top-dress: To apply fertilizer, by broadcasting, to the entire growing area after a crop is established.

Toxicity: Refers to the poisoning ability, in speed and severity, of a pesticide. The toxicity of a chemical to humans is usually based on its assumed (or known) effect on humans, and its known effect on test animals.

Transplanting: The removal of plants from one growing area or growing environment to another. In vegetable crop production some crops can be started in greenhouses and transplanted into the field, thus extending the growing season.

Weed: A plant growing where it is not wanted.

Wettable powder: Dry formulation of a pesticide which is normally mixed with water to form a sprayable suspension (e.g., Benlate 50 W).

Wetting agent: See surfactant.

Wireworm: A small 'wormlike' or 'caterpillar-like' insect that lives in the soil and is the larval stage of a beetle. These usually white, ivory or tan colored insects have hard, shiny outside coverings and can cause damage to seeds and root crops. Normal sizes range from 1 to 2.5 cm (0.25-1 in.) in length.

Variety: A botanical classification used to group or separate plants within a given species. Broccoli, cabbage and cauliflower are varieties of one species of plant. The term variety is commonly used to mean cultivar (cultivated variety).

Virus: A submicropscopic organism consisting of nucleic acid and protein. All plant viruses are parasitic.

Volatility: The evaporation (release by fumes) by pesticides (or any liquid or solid) after landing on the target plant. Also known as evaporation.

PUBLICATIONS AVAILABLE FROM ALBERTA AGRICULTURE

AGDEX NO.	
FS200/15-1	Sanitation and Disease Control Recommendations for Greenhouses, 1979.
202/845	Alberta Market Gardeners (a list of names, locations, sales methods and major crops). (Annual).
250/60	Commercial Storages of Fruits and Vegetables. AC 1532, 1974. FS252/20-1
	Commercial Cole Crop Production in Alberta. 1983.
254/20-2	Rhubarb Culture. AC 1664, 1978.
258/20-7	Commercial Rutabaga Production in Alberta. 1983.
FS258/20-2	Commercial Carrot Production in Alberta. 1983.
FS258/20-5	Commerical Onion Production in Alberta. 1983.
FS258/25-1	Causes and Control of After-Cooking Darkening of Potatoes. 1980.
FS258/635-2	Bacterial Soft Rot of Carrots. 1975.
FS258/635-3	Diseases of Potatoes and Their Control. 1981.
FS258/635-4	Blackleg of Potatoes in Alberta. 1977.
FS258/635-5	Bacterial Ring Rot of Potatoes in Alberta. Revised 1979.
FS258/635-6	Rhizoctonia of Potatoes. 1977.
FS277/20-2	Shelterbelts in Alberta. 1986.
277/645	Chemical Weed Control for Alberta Shelterbelts. AC 1511, Revised 1986.
731-1	Hobby Greenhouses in Alberta. 1986.
FS641-5	Canada Thistle - Its Biology and Control. 1984.
606-1	Guide to Crop Protection in Alberta, Part I - Chemical - Herbicides, Fungicides, Insecticides. Revised Annually.
744-5	Guide to Crop Protection in Alberta. Part III - Pesticide Application Equipment.
258/20-8	Potato Production Guide 1986-87.
609-1	Managing Herbicide Residues. April 1986.
744-7	Sprayer Cleanout. May 1986.
607-2	Guidelines for the Safe Use of Pesticides by Farmers. Revised January 1986.
640-4	Weeds of Alberta. Cost $10.00. Available from: The Provincial Museum of Alberta Book Store 12845 - 102 Avenue Edmonton, Alberta T5N 0M6 Cheques or money order must be made payable to the Provincial Treasurer.

Many other horticultural related publications are listed in the Publications List, revised yearly, and available from:

Alberta Agriculture
Print Media Branch
7000 - 113 Street
Edmonton, Alberta
T6H 5T6.

METRIC CONVERSION TABLE

ACRES TO HECTARES

1 acre = 0.4 hectares
2 acres = 0.8 hectares
3 acres = 1.2 hectares
4 acres = 1.6 hectares
5 acres = 2.0 hectares
6 acres = 2.4 hectares
7 acres = 2.8 hectares
8 acres = 3.2 hectares
9 acres = 3.6 hectares
10 acres = 4.0 hectares
20 acres = 8.0 hectares
30 acres = 12.0 hectares
40 acres = 16.0 hectares
50 acres = 20.0 hectares
60 acres = 24.0 hectares
70 acres = 28.0 hectares
80 acres = 32.0 hectares
90 acres = 36.0 hectares
100 acres = 40.0 hectares

HECTARES TO ACRES

1 hectare = 2.5 acres
2 hectares = 5.0 acres
3 hectares = 7.4 acres
4 hectares = 10.0 acres
5 hectares = 12.4 acres
6 hectares = 15.0 acres
7 hectares = 17.3 acres
8 hectares = 20.0 acres
9 hectares = 22.2 acres
10 hectares = 25.0 acres
20 hectares = 50.0 acres
30 hectares = 74.0 acres
40 hectares = 100.0 acres
50 hectares = 123.5 acres

APPLICATION RATE CONVERSIONS

Metric to Imperial (Approximate)

litres per hectare x 0.09 = gallons per acre
litres per hectare x 0.36 = quarts per acre
litres per hectare x 0.71 = pints per acre
millilitres per hectare x 0.015 = fluid ounces per acre
grams per hectare x 0.015 = ounces per acre
kilograms per hectare x 0.89 = pounds per acre
tonnes per hectare x 0.45 = tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23 = litres per hectare (L/ha)
quarts per acre x 2.8 = litres per hectare (L/ha)
pints per acre x 1.4 = litres per hectare (L/ha)
fluid ounces per acre x 70 = millilitres per hectare (mL/ha)
tons per acre x 2.24 = tonnes per hectare (t/ha)
pounds per acre x 1.12 = kilograms per hectare (kg/ha)
ounces per acre x 70 = grams per hectare (g/ha)
pounds/square inch (psi) x 6.89 = kilopascals (kPa)

°F = (°C x 9/5) + 32
°C = (°F -32) x 5/9

SEED COMPANIES

The following is a list of some seed companies commonly used by vegetable growers. This list constitutes neither an endorsement of these companies nor a suggestion that other companies do not supply vegetable seed and is only provided for the benefit of growers.

Abbott & Cobb
Box 307
Feasterville, PA 19047

Agway Inc. Seed Division
Box 4741
Syracuse, NY 13221

Alberta Nurseries and Seeds Ltd.
Box 20
Bowden, AB TOM OKO

Arco Seed Company
P.O. Box 181
El Centro, CA 92244

Asgrow Canada Ltd.
P.O. Box 610
121 Bridge Street
Bradford, ON L3Z 2B2

Ball Superior Ltd.
1155 Birchview Drive
Mississauga, ON L5H 3E1

C. Beemsterboer N.V.
Seed Growers and Merchants
Warmenhuizen, Holland

Bejo Zaden
P.O. Box 9
Dorpsstraat 612
Holland

Brotherton
P.O. Box 906
Moses Lake, WA 98837

Crites-Moscow
P.O. Box 8912
Moscow, ID 83843

Crookham Co.
Box 520
Caldwell, ID 83606

William Dam Seeds
Highway 8
West Flamboro, ON LOR 2KO

De Giorgi Company Inc.
1411 Third Street
Council Bluffs, Iowa 51501

Dessert Seed Co. Inc.
Box 181
El Centrol, CA 92243

Dominion Seedhouse
Georgetown, ON L7G 4A2

Ferry-Morse Seed Co.
P.O. Box 100
Mountain View, CA 94042

Gallatin Valley Seed Co.
Box 167
Twin Falls, ID 83303

H.G. German
P.O. Box 398
Smethport, PA 16749

Harris Seeds of Canada
R.R. #32, Highway 6
Hamilton, ON L8N 2F7

Herbst Brothers Seedsmen
1000 N. Main St.
Brewster, NY 10509

R.L. Holmes Seed Co.
2125 - 46th Street NW
Canton, OH 44709

Letherman's Inc.
1221 E Tuscarawas
Canton, OH 44707

McFayden Seeds
P.O. Box 1800, 30 - 9th Street
Brandon, MB R7A 6N4

Northrup King Co.
P.O. Box 1827
Gilroy, CA 95020

W.H. Perron & Co. Ltd.
515 Labelle Boulevard
City of Laval, PQ H7V 2T3

Pure Line Seeds Inc.
Box 8866
Moscow, ID 83843

Reed's Seeds
R.D. #2
Cortland, NY 13045

Robson Seed Farms
1 Seneca Circle
Hall, NY 14463

Rogers Brothers
P.O. Box 4727
Boise, ID 83711

Royal Sluis
1293 Harkins Road
Salinas, CA 93910

Seedway Inc.
Hall, NY 14463

Siegers Seed Co.
7245 Imlay City Road
Imlay City, MI 48444

Sluis and Groot of America Inc.
124 Griffin STreet
Salinas, CA 93901

Stokes Seeds Ltd.
Box 10
St. Catharines, ON L2R 6R6
Sun Seeds
9531 West 78th Street #229
Eden Prairie, MN 55344

Takii and Co. Ltd.
622 - 18th Avenue
San Francisco, CA 94121

T & T Seeds Ltd.
Box 1701
Winnipeg 2, MB R3B OW3

Otis S. Twilley Seed Co.
Salisbury, MD 21801

Vesey's Seeds Ltd.
York, PEI

Westcan Horticultural Specialists Ltd.
1900 - 11th Street SE
Calgary, AB T2G 3G2

Grower's Spray Record

Date Applied	Crop Treated	Stage of Growth	Field Identification	Pest Controlled	Chemical Used	Rate Used	Remarks (Weather, Notes, Etc.)

Grower's Spray Record

Date Applied	Crop Treated	Stage of Growth	Field Identification	Pest Controlled	Chemical Used	Rate Used	Remarks (Weather, Notes, Etc.)

VEGETABLE RESEARCH AND EXTENSION STAFF
ALBERTA DEPARTMENT OF AGRICULTURE

Specialized Area	Name	Position Description	Address	Phone
Vegetable Production	Paul Ragan	Research & Extension Horticulturist	Alberta Horticultural Research Center Bag 200 Brooks, Alberta TOJ OJO	362-1311
	Phil Dixon	Extension Horticulturist	Alberta Dept. Agriculture, R.R. #6 Alberta Tree Nursery & Horticulture Centre Edmonton, Alberta T5B 4K3	973-3351
Vegetable Storage Design	Dennis Darby	Farm Structures Engineer	Alberta Agriculture Service Centre Lethbridge, Alberta T1J 4C7	381-5114
Disease Control	Ron Howard	Plant Pathologist	Alberta Horticultural Research Center Bag 200 Brooks, Alberta TOJ OJO	362-1311
	Jim Letal	Plant Pathologist	Reg. Crops Lab Box 10 Olds, Alberta TOM 1PO	556-4282
		Plant Pathologist	Reg. Crops Lab Box 7777 Fairview, Alberta TOH 1LO	835-2291
Insect Control		Entomologist	Alberta Horticultural Research Center Bag 200 Brooks, Alberta TOJ OJO	362-1311
	Michael Dolinski	Entomologist	O'Donoghue Building 7000 - 113 Street Edmonton, Alberta T6H 5T6	427-5339
	Michi Okuda	Entomologist	Reg. Crop Lab Box 7777 Fairview, Alberta TOH 1LO	835-2291
	Jim Letal	Plant Pathologist	As above	
	Marilyn Steiner	Entomologist	Alberta Evironment Centre Bag 4000 Vegreville, Alberta TOB 4LO	632-1286
Weed Control	Rudy Esau	Weed Control Specialist	Alberta Horticultural Research Center Bag 200 Brooks, Alberta TOJ OJO	362-1311
Irrigation	R.C. McKenzie	Soil & Water Specialist	Alberta Horticultural Research Center Bag 200 Brooks, Alberta TOJ OJO	362-1311
Soil Fertility	R.C. McKenzie	Soil & Water Specialist	As above	
	Doug Penney	Soil Fertility Specialist	O'Donoghue Building 7000 - 113 Street Edmonton, Alberta T6H 5T6	427-5346
Storage & Handling	Ken Mallet	Post Harvest Physiologist	Alberta Horticultural Research Center Bag 200 Brooks, Alberta TOJ OJO	362-3391
Provincial Potato Specialist	Clive Schaupmeyer	Research Horticulturist Potato Crop	Alberta Horticultural Research Center Bag 200 Brooks, Alberta TOJ OJO	362-1311